Lennox Head

[Integrating Ecological and Built Communities in a Coastal Village]

Lennox Head, New South Wales, Australia - Nicholas Buesking - April 2013

Lennox Head: Integrating Ecological and Built Communities in a Coastal Village

LA 404: Landscape Architecture Comprehensive Project

Nicholas Buesking

Ball State University
College of Architecture and Planning
Department of Landscape Architecture

April 2013

[Abstract]

Addressing how coastal villages interact with their environment is an important facet of creating an ecologically sustainable future. This project seeks to integrate healthy natural systems and human development in the town of Lennox Head, which lies on the northern coast of New South Wales, Australia. The small village faces a number of compelling ecological issues: much of the forest ecosystems are gone, Seven Mile Beach is receding, and Lake Ainsworth is significantly degraded. In light of the town's expected growth in population, these issues are addressed through a town master plan that creates a framework for intelligent growth, green infrastructure, and restorative landscapes. The project also addresses these issues through the design of the Surf Life Saving Club site which will serve as a model for ecologically sustainable design and engage residents and tourists in the restoration process.

Ecological restoration efforts must be concerned with creating a holistic, diverse ecosystem that interacts with social and cultural needs in an ever-adapting process. These restoration efforts in the vicinity of Lennox Head focus on the beach, the coastal freshwater lake, and the remnants of littoral rainforest. Dune restoration rather than seawall construction on Seven Mile Beach is the most effective and environmentally sound solution of dealing with its erosion issues. To improve the lake's water quality and reduce erosion, green stormwater management strategies including filtration swales, infiltration basins, and pervious paving have been implemented. The shore is also revegetated with natural wetland and upland communities. Along the coast in town, littoral rainforest communities are also replanted.

To address the ecological sustainability of the town infrastructure itself, strategies included increased density development, native landscaping, a strengthened multi-modal public transportation system, stormwater management, local wastewater treatment, and various types of green infrastructure. To foster a sense of connection between people and nature, an anthropocentric viewpoint to ecological sustainability guided the project to capitalize on the village's natural beauty, implement community food production, and introduce public education on ecological sustainability. Transforming Lennox Head benefits the natural environment and also benefits the community through preserving its natural heritage, protecting the cultural landscape of Seven Mile Beach, and increasing the community's quality of life. Implications of this project extend beyond its direct physical benefits to Lennox Head. Since Australia has over two hundred coastal towns, this project can readily serve as a model for sustainability for other small, Australian beach communities, and potentially others around the world.

[Acknowledgements]

I would like to thank everyone who has helped in the development of this project. Specifically, I would like to thank my professors Susan Tomizawa and Les Smith for their efforts to shape the background and research of the project. I would also like to thank John Motloch and Chris Marlow for their desk crits and feedback throughout the semester on my design. Similarly, I especially would like to thank my faculty mentor, Meg Calkins, who has helped give me direction and develop a deeper level of understanding behind my design.

In addition to college faculty, I want to thank the residents of Lennox Head. They have contributed significantly to my design process by generously providing their time, resources, and feedback.

[Table of Contents]

[Introduction]

Lennox Head is a small village on the northern coast of New South Wales, Australia, with a population of around 7300. The town has two major geographical features: Lennox Point, a headland known internationally for its surf conditions, and Lake Ainsworth, a coastal freshwater lake. On weekends and holidays, many people from the region flock to the town to enjoy both the beach and the lake. These two features heavily influence the cultural identity of the town.

In striving to become ecologically sustainable, a coastal village like Lennox Head must redefine how it interacts with its environment. Michael Hough writes: "Humanity and nature have long been understood to be separate matters. Such a dichotomy has had profound influences on the way people have thought about themselves: the cities where people live and the non-urban regions beyond where nature lives" (*Cities* 8). Ecological sustainability requires a new paradigm on development: an integration of natural and built environments. The redevelopment of the village of Lennox Head can therefore benefit the community ecologically and socially through the preservation of the natural heritage of the region, the protection of the cultural landscape of Seven Mile Beach, the reduction of the town's environmental impact, and the increase in the community's quality of life. The project handles these goals on two different scales: the town as a whole and the site of the Surf Life Saving Club. Through the combination of a deep value for human quality of life and an overarching concern for the ecological health of the region, Lennox Head can become a synergetic coastal village, moving toward a sustainable future that meets the needs of both the environment and society.

[Definitions]

- **Ecological sustainability**: the pattern of human development which remains within the capacity of the Earth's natural environment.
- **Ecological restoration**: the practice in which ecological habitats destroyed or damaged due to human development are re-introduced or made healthy again.
- **Best Management Practices (BMPs)**: standard methods of dealing with a particular issue such as dune restoration or green infrastructure that have been proven to be effective through previous implementation.
- **Community**: the collective group of people who populate a city, town, or village forming a network to share goods, services, entertainment, leisure, and politics.
- **Plant community**: the natural group of species which inhabit a particular ecosystem.
- **Village**: a human development with a population below 10,000 residents that lacks the critical infrastructure necessary to sustain itself such as hospitals, wastewater treatment, energy production, transportation systems, and schools.
- **Infrastructure**: the network of constructed systems that is necessary for human settlement including roads, sewers, utilities, and buildings.
- **Green infrastructure**: the network of ecological and constructed systems utilized in urban or other developed areas to promote ecological sustainability by fostering ecological functions useful to human society and the environment.

[Background]

Introduction

This research examines the methods necessary to redesign the small coastal town of Lennox Head to be ecologically sustainable. It addresses the current environmental state of Lennox Head's surroundings and analyzes means of ecological restoration that are pertinent to the community. Specifically, methods of addressing erosion issues at Seven Mile Beach have been evaluated on the basis of their sensitivity to the environment and provision of ecological benefits. Beyond habitat restoration, a framework for ecological sustainability requires reducing the impact of cities and towns through integrating natural and built landscapes. Because current sustainable design tends to focus on either the large urban scale or small site scale, common practices have been analyzed for their applicability to a small town in a coastal context. Furthermore, in order to stimulate social integration with the design, this research examines design theories, physical landscapes, and community programming that will help the residents of Lennox Head understand and value the physical changes to the town.

Ecological Restoration

The ecosystems surrounding Lennox Head have been degraded through human development. In the Ballina Shire, Lennox Head's local governing region, over 60% of five different forest ecosystems have been cleared for development and agriculture. In addition, over 99% of Big Scrub habitat is gone in the upper north New South Wales region (Ballina Shire Council, *State of the Environment* 14). In addition, the dune ecosystem along Lennox Head has been disappearing, a problem which will be discussed further in Section 2.2. Creating a framework for ecological restoration is an essential task in fostering a community's ecological sustainability.

Because of the unpredictability of nature, restoration cannot be based on a strictly linear approach. Harker *et al*. emphasizes, "Since nature is dynamic, the most we can ever do is establish the conditions for natural processes to work" (1). In response, the design of a complex system, such as an ecological habitat, must adapt to nature over time rather than force specific outcomes (Lister 539). On the other hand, degraded environments will not grow back to health without human management (Higgs 343).

Biological success is the primary defining factor of ecological restoration. As such, one important distinction must be made: Restoration is not simply the replanting of a few token indigenous plants to assuage the public's conscience over environmental health. It must focus more on the creation of an environment that is close to the goal historical habitat (Higgs 343). The former is not completely without value, however, in the right context. It is called natural landscaping, the practice of using indigenous plants without attention to ecological systems (Harker *et al.* 19). While natural landscaping has some value, especially in urban environments, restoration contributes significantly more to ecological health. Truly, pursuing a genuine redevelopment of historical ecological processes and biological communities is the foundation for good restoration practices. Higgs states, "Ecological fidelity is the avowed goal of restoration" (343). The basic requirements for establishing ecological integrity are creating appropriate structure and arrangement, stimulating the function of natural processes, and establishing stability (Higgs 338). Restoration requires one of two physical

design principles: either large sections of habitat or small patches linked by habitat corridors. Patches of habitat should be in close proximity to one another; the farther apart they are, the less ecological connection they share (Harker *et al.* 25-30, 29-32, 36).

Many projects focus solely on these ecological factors of restoration. This approach is based on an ecocentric philosophy, in which nature is inherently valuable. Under this philosophy, however, nature and society are viewed as two separate entities. Higgs suggests that ecological restoration focused in this way can only create an *effective* solution, which he distinguishes from a *good* solution (338). Because the purpose of the redevelopment of Lennox Head is to create a small town seeking to integrate healthy natural systems and a community, an ecocentric approach that ignores social and cultural aspects is not appropriate.

On the other hand, a good, adaptable ecological restoration involves an anthropocentric overlay on top of the ecocentric perspective. While cultural influences derived from an anthropocentric viewpoint can detract from the ecological success of the restoration by compromising ecologically centered goals, such consideration is still necessary. Because ecological restorations affect human interaction with the land, those that address both community desires and ecological functionality are more likely not only to succeed but also to last (Higgs 339, 346). At Lennox Head, aesthetics should play a key role in the ecological restoration process because of the site's natural beauty. Furthermore, due to its iconic nature to the community, the cultural landscape of the beach in an Australian coastal town like Lennox Head should be regarded as valuable in the restoration process. These factors will help drive the design to incorporate the pressure of human society on ecological systems as a beneficial force, not a destructive one. By creating synergetic relationships between human society and the land, an ecological restoration project will become more successful than if it relied solely on ecocentric principles.

This sort of relationship has the potential to be modeled best in Lennox Head at Lake Ainsworth. Although the lake is still actively used by the community, a number of ecological issues prevent it from fulfilling its full cultural and environmental potential. Coastal freshwater lakes, like Lake Ainsworth, are naturally oligotrophic. Their low levels of nutrients make them easily affected by influences such as recreation, development, adjacent land use, and fire. Even a small increase in nutrient levels in the lake can lead to eutrophication (Saunders 13-14), a problem that has caused serious algal blooms in Lake Ainsworth (Ballina Shire Council, *Lake Ainsworth* 26). While full restoration may be impossible due to eutrophication, nutrient levels need to be reduced in order to encourage healthier, more natural ecological conditions. The Queensland government recommends that "a buffer of intact native [...] vegetation is an effective way of maintain the ecological and hydrological functioning of a wetland—it also reduces impacts from adjacent land uses" (Saunders 13). The *Lake Ainsworth Management Plan* suggests placing wetland fore-bays at stormwater drains and treating runoff from impervious surfaces to prevent more nutrients from entering the lake (Ballina Shire Council, *Lake Ainsworth* 27-28). Besides water quality, Lake Ainsworth has issues with erosion, chiefly along the south and eastern shores. This erosion has three primary causes: heavy human traffic on sandy grass, vehicles parked on unpaved surfaces, and runoff from drains and impervious surfaces (Ballina Shire Council, *Lake Ainsworth* 75). The *Lake Ainsworth Management Plan* recommends the reintroduction of reed beds to the shores to reduce erosion, also citing habitat and pollution mitigation benefits

(Ballina Shire Council, *Lake Ainsworth* 28). Habitat is also important to restoration efforts at Lake Ainsworth. In its immediate surroundings are opportunities to restore a number of threatened habitats including coastal wetlands, littoral rainforest (van Iersel 33), and swamp sclerophyll forest on coastal floodplain (Hewitt 14). To strengthen the quality of ecological systems in and around Lake Ainsworth, nutrients need to be removed through biological and physical methods, stormwater must be treated through vegetative buffers, erosion needs to be controlled via emergent plants and well-planned paved surfaces, and surrounding habitat must be restored.

Ecological restoration efforts in Lennox Head must be concerned with the creation of a holistic, diverse ecosystem that interacts with social and cultural needs in an ever-adapting process. By incorporating human interest into the restored landscape, the success of the ecological communities in question will be improved in the long run. Ecological restoration efforts in the immediate Lennox Head area should focus on Lake Ainsworth, Seven Mile Beach, and the remnants of littoral rainforest between the other two.

Beach Restoration

Beach erosion is a common phenomenon near coastal developments. At Lennox Head, Seven Mile Beach has been receding; as a result, the shoreline is creeping towards the town, eroding dunes and destroying their corresponding ecosystems. Long term erosion occurs due to a net loss of sand (New South Wales 6). It is this type of erosion that is dangerous to beaches, dune habitats, and coastal developments. On the other hand, short term erosion is a natural, cyclical process that involves beach erosion during storms, which builds bars in the near shore region. The beach is then rebuilt gradually during calmer conditions from the offshore sand bars (New South Wales 3, 6). In fact, Watson and Adams say that the "process of beach and dune formation is an enduring cycle, which left on its own, creates a self-sustaining ecosystem" (155). This sort of self-perpetuation is an essential element of a healthy ecosystem. Any action to protect Seven Mile Beach must focus on creating an equilibrium of sand accretion and erosion by limiting long term erosion.

Erosion is not new to the region; Seven Mile Beach has a history of it. The years from 1947 to 1976 were characterized by high storm intensity, resulting in consistent erosion. After that time, however, because of a surplus in sand supply, the beach began to recover (Witt 6-27, 6-36). At the present time, Seven Mile Beach is operating under a deficit of sand due to an interruption in the normal littoral drift pattern. A training wall at the Richmond River outlet about 9.3 km south of Lennox Head along the coast blocks sand that normally would travel to the beaches north of the river. Witt predicts that once the beach on the south side of the training wall has reached equilibrium, the sand supplied by littoral drift will return to normal. He does not, however, discuss how long this might take. Nevertheless, experts predict that Seven Mile Beach could continue to recede at a rate 0.5 meters/year (Witt 4-13, 6-38, 6-39).

Many strategies have been developed to protect shorelines. Two major categories exist: structural and nonstructural. Structural approaches such as seawalls, revetments, levees, and groins rely on heavily engineered solutions. The village of Lennox Head constructed two substantial seawalls after 1993 because of coastal erosion problems (Hewitt 71). Seawalls, however, do not help build beaches but rather prevent further loss of land to beach recession. Land inland of the

seawall is safe from beach recession, yet waves reflect off the seawall and increase beach loss. Revetments—a seawall using large boulders instead of a paved surface—avoid this problem because the boulders dissipate wave energy instead of reflecting it (Watson and Adams 161). Witt still warns against the dangers of any sort of hard surface solution, saying, "When shoreline recession is prevented by the construction of seawalls, the sand behind is effectively isolated from the beach system. The erosion is then transferred downdrift (to the north) where any previous erosion trend will be exacerbated" (6-38). These solutions are not acceptable to combat erosion because they would simply push problems farther down Seven Mile Beach.

A number of non-structural approaches to beach protection also exist. One common technique is beach nourishment. Sand is artificially supplied to the beach from another source, either by dredging a nearby sandbar or importing sand from a distance. The effectiveness of beach nourishment can last up to fifteen years; however, in most cases this technique needs to be repeated. As such, it is an expensive option (Watson and Adams 164). The *Ballina Coastline Management Study* encourages using a scaled down version of this option in conjunction with other strategies in order to minimize costs and improve results (Hewitt 53, 64, 78). Used as the sole strategy for beach protection, beach nourishment would only act as a temporary bandage for the problem; it does not actually prevent beach erosion in any way. It would only be an effective solution in Lennox Head if the sand supply was stable; however, due to the Richmond River training wall, it is not. If Seven Mile Beach's sand supply ever does stabilize, beach nourishment would be a viable method to establish an initial healthy supply of sand with which the beach could use to rebuild.

Another nonstructural approach is the restoration of coastal dune systems. Healthy dune ecosystems are important to coastal communities and habitats. Acting as transitions from beach environments to inland habitats, they are the first line of defense for land near the coast. Dune systems help reduce erosion that could be caused by wind, salt spray, and waves (New South Wales 3). They can also lower the chance of flooding (Watson and Adams 167). This protection buffers the beach against serious erosion and subsequently shoreline recession. Healthy dunes systems typically consist of three major sections: hind dunes, foredunes, and incipient dunes. Incipient dunes are often ephemeral shelves of sand, forming and disappearing through natural cycles. Foredunes, the largest, are often damaged by large waves during storm events but also naturally regenerate. When protected by foredunes, hind dunes are stable landforms that host larger vegetation (New South Wales 3, 11). Dune systems, because they are inherently dynamic, are able to utilize natural processes to adapt to changing conditions over time, creating a more resilient beach. Restoring dune systems, the Seven Mile Beach's natural defense, would foster ecological sustainability by not only protecting the beach but also by stimulating lost habitat.

Restoring dunes is a complex process involving both geomorphological and biological aspects. One of the primary best management practices of creating dunes is using dune forming fences. Fences are placed perpendicular to prevailing winds where a dune is desired; over time, wind-blown sand is slowed by the permeable mesh that covers the fence, encouraging the formation of a dune. This process is gradual (New South Wales 45, 47). These fences have been successfully implemented in both Louisiana and South Carolina, each taking less than half a year (Khalil 16 and Cribb). Using dune forming fences, however, will only be effective if

adequate sand is available. The biological aspect of revegetating dunes is a vital component in creating a healthy system. Vegetation cover helps stabilize the dunes (Watson and Adams 163), protecting sand from both wind and wave action. Furthermore, replanting dune vegetation helps encourage a healthy ecosystem through biodiversity. The primary vegetation zone generally consists of grasses and creepers that reinforce sand against the force of waves and wind. The secondary zone consists of woody shrubs which performs a similar function to the primary zone. These plants are found primarily on the foredune until vegetation begins to transition into taller shrubs and coastal trees in the interdunal region. Coastal trees, located at the back of the dune habitat, protect land farther inward by pushing wind up and over the canopy (New South Wales 11, 20, 79). To create an effective restoration, a designed intervention should make use of the systems which naturally respond to on-site conditions.

Traditional structural solutions to coastal erosion such as seawalls, although permanent, tend to damage either the immediate beach or the beach downdrift even more. Since Seven Mile Beach is an integral part of the community of Lennox Head, nonstructural techniques are more appropriate methods of dealing with erosion. Dune restoration, employing fences to regenerate dune structure and using indigenous plants to vegetate the surface, is the most effective and environmentally sound solution for Lennox Head, although it will take years to become fully realized. Used in combination, these methods of dune restoration will create a dynamic, ecologically sensitive approach to protecting Seven Mile Beach.

Integrating Built and Natural Landscapes

In addition to encouraging ecological systems outside of development, the village of Lennox Head itself must adapt to reduce its impact on the environment. Prevailing sustainable urban design principles and methods that deal with integrating built and natural landscapes have been examined for their ability to fit the context of Lennox Head. Some common methods for the integration of urbanism and ecology include land use, transportation networks, water treatment and management, and green infrastructure.

Land use is an overarching method of integrating built and natural landscapes affecting all other methods discussed. The Linnaeus Estate, an eco-resort Less than six kilometers north of Lennox Head, aims to create a sustainable community in which its residents act as stewards of the site's (*The Linnaeus Estate*). Its primary means of preserving natural ecosystems is by leaving most of the estate undeveloped. In fact, development at Linnaeus encompasses no more than 1% of the land—a number which typically ranges up to 50% in standard developments (Hordern). The strategy of limited development at the Linnaeus Estate cannot apply to a town of several thousand residents since it relies on a model of exceptionally low density. Currumbin Ecovillage, a sustainability-based neighborhood about seventy kilometers north of Lennox Head, differs in that it integrates higher levels of development into the 272 acre site. Although it was able to retain 99% of the native trees that naturally existed on-site, development consists about 20% of land coverage, a number still well below normal. Even so, the neighborhood boasts the same yield as standard development (*The Ecovillage at Currumbin*). Because the town is projected to grow by two thirds, infill and higher density

development seems to be a more appropriate solution than low density greenfield models. LEED-Neighborhood Development (LEED-ND) and the Sustainable Sites Initiative (SITES) both reward infill and habitat preservation (*LEED* vii), (The Sustainable Sites Initiative 22, 24, 26-27).

The transportation sector provides many opportunities to encourage and improve ecological sustainability. Even though many of the sustainable strategies dealing with transportation do not explicitly facilitate ecological habitat, they do promote ecological health by reducing the environmental impact of transportation systems. Both Green Star in Australia and LEED in the U.S. promote similar goals: Green Star Communities rewards integrated transportation planning, mass transit, and shared parking facilities (*Green Star*) while LEED-ND encourages walkable streets, bike networks, and reduced parking footprints (*LEED* vii). The city of Portland approaches the issue of transportation by not just reducing infrastructure but also by improving it. Some of its stated goals for the road system as published in *Green Streets* include fostering ecological habitat and natural processes, redefining the public right of way as a place for more than just vehicular transportation, and creating aesthetic street landscapes to promote quality of life (Metro 6). These strategies suggest that walkability and bike connections are important in Lennox Head to reduce the need for personal vehicles and also that streets and parking lots should host more ecological functions. Lennox Head already utilizes some public transportation, connecting to the other small towns in Ballina Shire via a reliable regional bus network. In addition, the Ballina Shire Council has established a plan to connect a bike path from Ballina to the north of Lennox Head (GeoLINK, *Lennox Head* 39-41). Bike connections north to Byron Bay and walkability in Lennox Head still need to be addressed.

Systems that handle stormwater are also important because water quality is closely linked to ecological health. The Linnaeus Estate takes a watershed approach to water quality. A vast majority of the catchment remains undeveloped in order to prevent human pollutants from entering the water and to allow the forest to provide natural treatment (*The Linnaeus Estate*). On the other hand, Currumbin Ecovillage takes a localized approach, using rainwater harvesting to lower stormwater surge and reduce potable water usage (*The Ecovillage at Currumbin*). These two approaches are not mutually exclusive. Portland bases its strategy of green streets on watershed management through localized action such as stormwater basins, bioretention areas, swales, and pervious paving to increase infiltration, mitigate pollution, and reduce stormwater entering sewer systems (Metro 46, 51, 57, 61). Reducing stormwater volume is vital to Lennox Head. Van Iersel notes in the *Ballina Coastline Management Study* that stormwater currently discharges over the beach in eight places at Lennox Head, which can cause local erosion, bank collapse, high speed water flow, and polluted discharge (12). All these can exacerbate problems with beach erosion. Therefore, stormwater must be dealt with in Lennox Head both on a large scale, through watershed management, and locally, through green infrastructure such as bioretention areas, vegetated swales, and pervious paving. Combining these strategies creates a holistic approach to reduce the quantity and improve the quality of water entering the ocean and Lake Ainsworth, preventing other environmental issues.

The most common technique of integrating natural and built environments is the use of green infrastructure. A wide range of practices have been developed in this area. Green spaces such as naturalized parks and nature centers provide ecological function to a community. The article “Can Green Infrastructure Promote Urban

Sustainability?" makes the case that green spaces should not be considered simply as an ecological asset but as a multi-functional opportunity to connect people and the landscape (Mell 26-27); this assessment fits with an anthropocentric view of promoting ecological habitat. Existing green spaces in Lennox Head, including Williams Reserve and the Surf Life Saving Club lawn, should thus be treated as an opportunity not simply for ecological habitat but also for community interaction with such environments. Another common practice is the use of green roofs, which can provide native habitat in places traditionally devoid of ecological value. Beyond providing habitat, green roofs have the additional benefits of naturally cooling buildings, mitigating urban heat island effect, and managing stormwater (The Sustainable Site Initiative 66, 118, 121). In *The Landscape Restoration Handbook*, Harker *et al.* promotes the use of natural landscaping in various small applications such as around signs, restaurants, roads, shelters, parking, unused mowed lawn, and steep slopes. Even though such small applications are too fragmented to create a true ecosystem, it can lower maintenance, decrease environmental impacts, and increase basic ecological value (43). These requirements by themselves, although creating some beneficial habitat, fail to adequately address broader ecological health because of their lack of connectedness to other efforts. On the other hand, because the city of Portland addresses these types of interventions in the context of the entire watershed (Metro 2), its approach begins to develop truly sustainable solutions. It places heavy emphasis on using green infrastructure to bring ecological functions into the city through their street systems (Metro 9, 46, 50, 57). Based on the literature, green infrastructure applicable to Lennox Head include green roofs on commercial buildings and non-beach style residences; natural landscaping in commercial, recreational, and residential regions; retrofitted streets to incorporate trees, bioretention areas, and other natural systems; and green spaces which bring ecological function and community together in the same space.

Public Acceptance

Modern society tends to think of urbanism and nature as opposing forces, a concept that has existed since medieval times. In *Cities and Natural Processes*, Hough puts forth a similar idea by saying, "Humanity and nature have long been understood to be separate matters. Such a dichotomy has had profound influences on the way people have thought about themselves: the cities where people live and the non-urban regions beyond where nature lives" (8). As discussed earlier in Section 2.1, however, design with a heavy emphasis on natural systems is more likely to succeed if it integrates both ecocentric and anthropocentric viewpoints. The following examines potential design theories, physical landscapes, and community programming that could lead to a successful integration between built and natural landscapes.

Bjarke Ingels, a leader in innovative sustainable design, proposes that cities can become sustainable in a way that increases quality of life through his philosophy of hedonistic sustainability. His approach to design is to capitalize on people's natural desires, such as fun and social interaction (Ingels). This concept is important in attempting to integrate ecology and human development because this approach makes people excited about sustainable design, not reluctant. Quality of life is an integral part of Ingel's theory of hedonistic sustainability. In order to shift public perception through stimulating quality of life, it is first necessary to

understand its basic characteristics. Felce and Perry propose five dimensions to individual well-being: physical, material, social, emotional, and development/activity (51).

Material well-being applies especially well to the theory of hedonistic sustainability. People can easily recognize the material benefits of food production and equitable transport opportunities. Food production in an urban environment has been clearly shown that it can benefit a large number of people. Completed in 2006, the Gary Comer Youth Center in Chicago hosts an 8,160 square foot garden on its roof which can produce over a thousand pounds of fruits and vegetables a year. This produce serves up to 175 children a day as well as several restaurants ("Gary Comer"). Being a part of the community center, the garden has the opportunity to engage those at the youth center with functioning ecological systems while at the same time producing fresh, local food for the same people. In Lennox Head, local food production has great potential. Already, regionally grown produce is sold at the monthly market along the eastern edge of Lake Ainsworth. A community garden near the lake as well as other urban agriculture initiatives throughout the town could have extended economic, physical, and social benefits. The other applicable aspect of material well-being, transportation opportunities, has already been discussed in Section 2.3 regarding bus and bike options.

By improving physical well-being, sustainable design can shift people's perceptions about sustainability. The designed landscape can in fact have an impact on human health. Stratus Consulting reports that a green infrastructure system in Philadelphia intended to lower stormwater pressure on sewer systems has significant ability to lower the ambient air temperature of the streets. Tree and other vegetative cover provide shade, mitigating heat gain from asphalt, concrete, and rooftops. As a result, it is predicted that with the implementation of 50% low impact development, over the course of forty years approximately 196 deaths caused by heat will be prevented in Philadelphia (Stratus Consulting 4-2, 4-3). Such a reduction of temperature is especially desirable in the hot summers of Australia. Furthermore, the study also suggests that green infrastructure will promote good air quality by reducing baseline pollution emissions of buildings through natural cooling and by actively cleaning the air (Stratus Consulting 4-6, 4-7). Although Lennox Head does not deal with heavily polluted air from industrial sources, improved air quality is always beneficial to public health. Through increased proximity vegetative cover and ecological function, ecologically sustainable design in Lennox Head can increase residents' health and well-being by providing more comfortable, safer temperatures in the hot climate of Australia.

Improving public perception through hedonistic sustainability is most effective in the area of social well-being. By creating a livelier town through stimulating social interaction and cultural events, people will interact with a sustainable environment while having fun and feeling more a part of the community. Lake Ainsworth is already a highly active social node in the community. It is estimated that during peak season, up to 1500 people use the lake per day (van Iersel 79). Various activities that occur in this area include swimming, sailing, canoeing, picnicking, walking, bird watching, market shopping, sun-bathing, and relaxing (GeoLINK, *Lake Ainsworth* 47). Based on personal observation, common activities on Seven Mile Beach near the Surf Living Saving Club include swimming, surfing, kite surfing, sand sculpting, walking, and running. An estimated 400 cars per day come through this end of the town for the purpose of recreation (GeoLINK, *Lake Ainsworth* 47). A sustainable redevelopment of this area must

seek to embrace the already lively culture of the place, creating even richer layers of social interaction. The Evergreen Brick Works project in Toronto gives insight to possible additions to programming. The industrial reclamation project created means for social interaction and activities by transforming into a community development that aims to bridge the distance between urbanism and ecology. Its master plan included an environmental learning center, children's gardens, an organic restaurant, farmer's market, and event facilities. These elements were all placed with the purpose of turning public attention to environmental issues (Lister 543). The Linnaeus Estate, on the other hand, is predominantly focused on the restoration of the site. Available activities, such as paths through renewed habitats, exist more to exhibit the restoration rather than to serve as an amenity for residents. These case studies suggest a number of potential program elements for the community space on the south shore of Lake Ainsworth: a learning center, food gardens, and event spaces.

The Lake Ainsworth area also has potential to improve well-being through education. Public education arose as a particularly common theme in case studies on sustainable development. Both the Evergreen Brick Works and the Linnaeus Estate contain heavy educational elements. At the Evergreen Brick Works, the learning center is core to changing public attitudes about sustainable living (Lister 454). At the Linnaeus Estate, sustainable philosophy is deeply rooted in the experience. It hosts a number of school groups to study the ecological systems on-site (*The Linnaeus Estate*). Portland (Metro 6) and Currumbin Ecovillage (*The Ecovillage at Currumbin*) also utilize public education as a means of creating a more favorable public image about the incorporation of ecological systems within an urban context. The prevalence of educational programming in a wide scale of ecologically-based sustainable projects suggests that similar programming in Lennox Head would help stimulate a higher public opinion.

For integration between built and natural landscapes to be successful in Lennox Head, it is necessary to give value to an anthropocentric viewpoint because the public must perceive a benefit to their quality of life. Particularly by fostering a sense of hedonistic sustainability and increasing community well-being through design, community perception can change.

CONCLUSION

Ecological restoration of Lake Ainsworth, restoration of the beach and its dune systems, and an integrated ecological and urban network are necessary to achieve ecological sustainability in the village of Lennox Head. In order to achieve ecological sustainability as a coastal village, Lennox Head must pursue additional methods beyond ecological restoration. The village itself needs to reduce its environmental impact by integrating natural and built landscapes. Design elements that are relevant to a small, coastal town include infill development, watershed management, naturalized stormwater management, and green infrastructure. Movement toward ecological sustainability should occur through the anthropocentric lens of hedonistic sustainability, appealing to the community's desire for increased quality of life. By combining a deep value for human quality of life with an overarching concern for the ecological health of the region, Lennox Head can become a synergetic coastal village, moving toward a sustainable future that meets the needs of both the environment and human society.

Figure 2.1 Lennox Point

Figure 2.2 Lake Ainsworth

Figure 2.3 Downtown Lennox Head

[Setting]

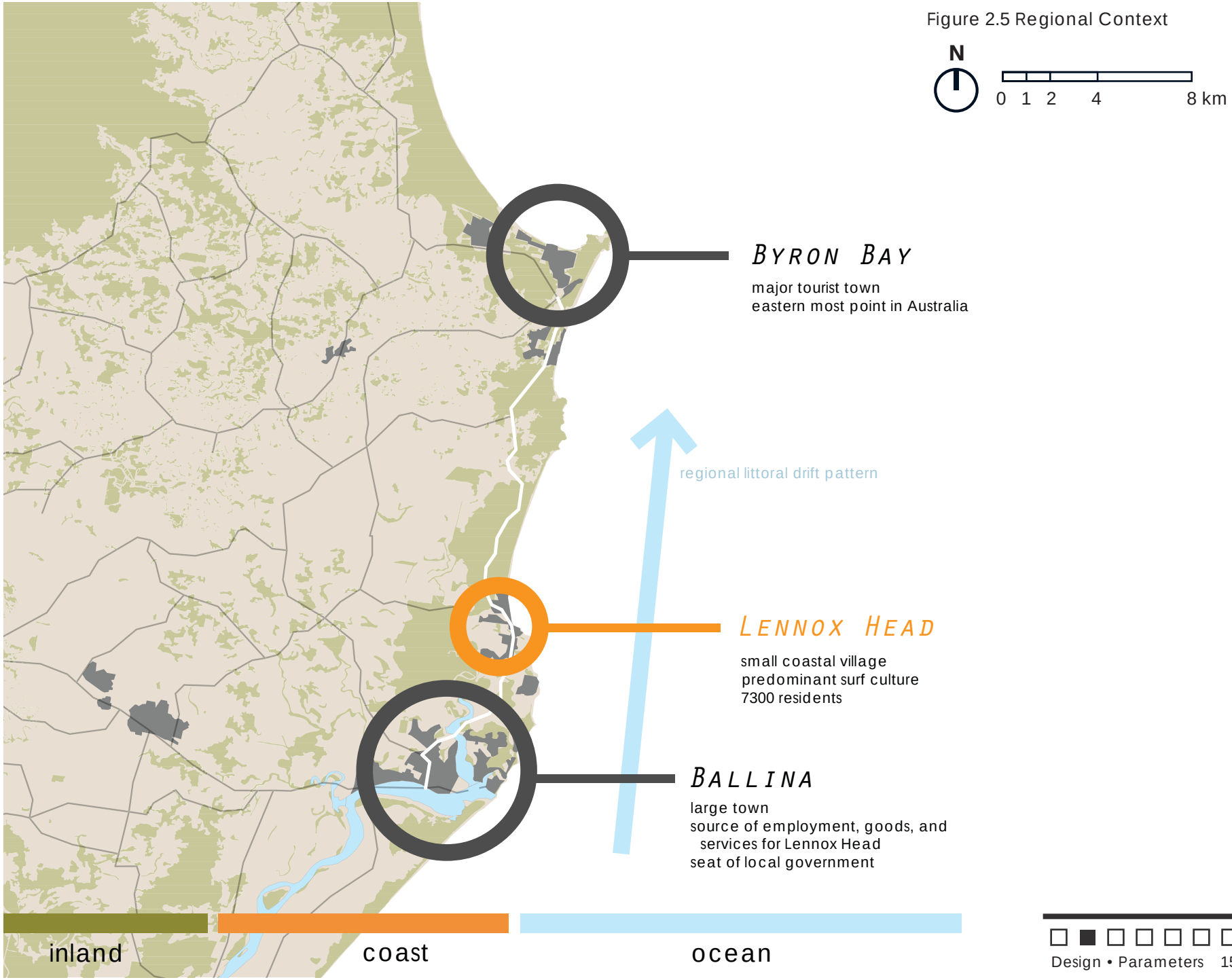
Lennox Head is a small village of about 7,300 people on the east coast of Australia just south of the New South Wales and Queensland border (Figure 2.4). Temperatures never drop below freezing, resulting in two primary seasons: rainy and dry. Along the coast exists a range of natural vegetation including temperate and subtropical rainforest, coastal heath, and swamp sclerophyll.

Lennox Head lies between two major towns, Byron Bay and Ballina, connected by a coastal road. Byron Bay has a strong surf tourism industry, and Ballina is the seat of the local government (Figure 2.5). The town itself is at the southern end of Seven Mile Beach, near Lennox Point (Figure 2.1). Due to its internationally known surf conditions, the town has a huge surf culture. Lake Ainsworth, a coastal freshwater lake, bounds the north end of town (Figure 2.2). Like the Point, it is another highly valued natural asset of the town. On weekends and holidays, many visitors from the surrounding region flock to the beach and the lake to surf, swim, and sunbathe.

The village's main road, Pacific Parade, runs along the beach. Only a small number of shops and other stores can be found in Lennox Head, generally clustered on the south end of Pacific Parade (Figure 2.3). Many of these are eateries or tourist oriented shops. As a result, residents must travel to the nearby town of Ballina to get goods, services, entertainment, and often even jobs.

Figure 2.4 National Context

Figure 2.5 Regional Context

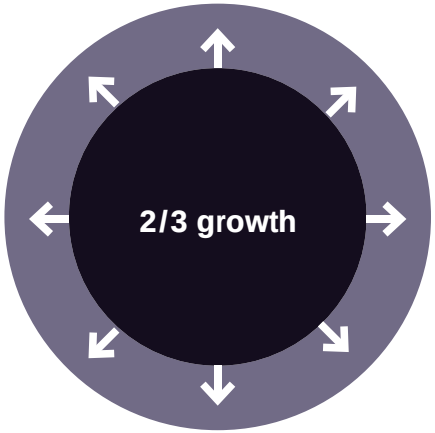


[Problem Statement]

Addressing how coastal villages interact with their environment is an important facet of creating an ecologically sustainable future. This project seeks to move toward a new definition of development by integrating healthy natural systems and human infrastructure in Lennox Head, New South Wales, Australia. This integration is accomplished through addressing both the future land patterns of the town as it expands and an ecologically restorative landscape surrounding the Surf Life Saving Club near Lake Ainsworth. The design protects the village's key ecological and built features, establishes a network to restore the receding beach, and creates ecologically beneficial urban landscapes. It also addresses how people perceive their environment, encouraging them to find value in an integrated landscape.

[Issues]

Lennox Head is facing major expansion. While population trends have been relatively stable, the town is expected to grow by two thirds in the upcoming years. For a village of 7,300 residents, the population would increase by 4,850 residents. With current patterns of development, another 207.1 ha of land would be required to meet the rise in population (Figure 2.6). Such a quick expansion creates a high potential for sprawl. The current development of the town, on the other hand, has already caused a number of ecological issues (Figure 2.7). The dunes throughout the town have been significantly eroding, causing the shoreline to recede. Several revetments have been added to prevent to shoreline from receding farther. Between the dunes and the town, much of the littoral rainforest habitat that once covered the region has been removed to create views to the ocean. The coastal freshwater lake, Lake Ainsworth, north of town is dealing with water quality and erosion issues. As the town expands, it is important to address these ecological issues together with patterns of new development to achieve the integration of built and natural communities.



Current:
- Population: 7,300 residents
- Land Coverage: 310.5 ha

Expected:
- Growth: 4,850 residents
- Land Need: 207.1 ha (+67%)

Figure 2.6 Projected Town Expansion

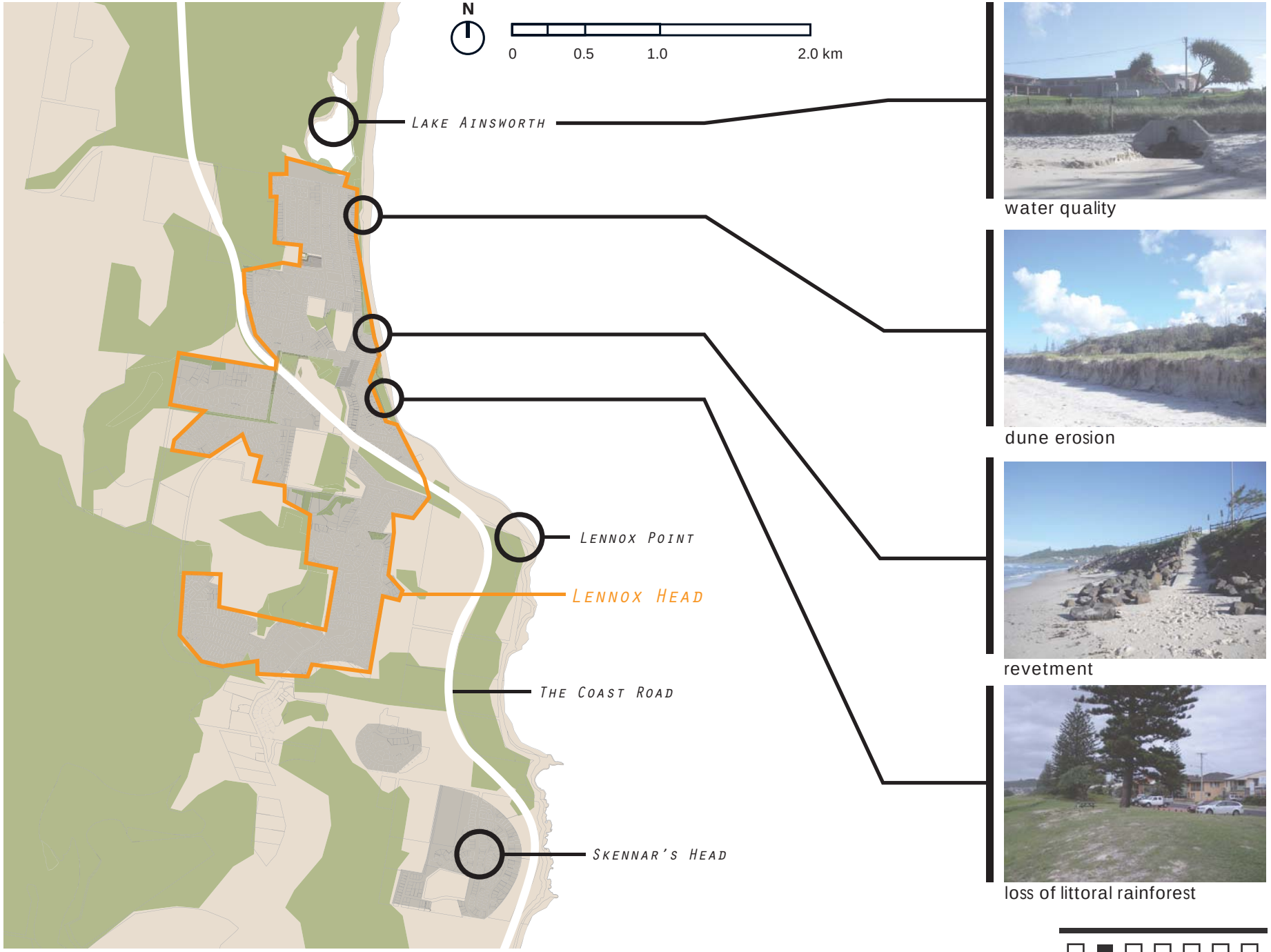


Figure 2.7 Town Ecological Issues

[Assumptions]

- Without intentional integration and public education, Lennox Head would continue to encroach upon its natural context.
- If left unaddressed, the erosion of Seven Mile Beach at Lennox Head would continue.
- Protecting the beach is preferable to letting natural coastal processes erode parts of Lennox Head.
- Under normal circumstances, the town would opt to utilize seawalls to prevent the loss of developed land.
- Green infrastructure alone cannot create ecological sustainability because it does not address human behavior and lifestyle.
- The state, which owns Lake Ainsworth Caravan Park, is willing to work in cooperation with the town and Surf Life Saving Club for the purpose of redeveloping the southern shores of Lake Ainsworth.
- The market that currently operates on the north end of Pacific Parade will be moved to the town center.

[Delimitations]

- Specific restoration and management plans for all of the natural habitats surrounding Lennox Head were not created.
- This project does not address restoration of the entirety of Seven Mile Beach. It focuses only on the portion linked with Lennox Head.
- The necessary removal of invasive species in order to ensure healthy ecosystems has not been directly addressed.
- Green infrastructure dealing with architectural practices is not addressed in regards to ecological sustainability.
- Site level design does not include the entire town of Lennox Head but instead uses the southern Lake Ainsworth region as a model for the rest of the village.

[Significance]

The redevelopment of the village of Lennox Head provides both tangible benefits to the community as well as a theoretical framework for the field of landscape architecture. Its benefits include improved health of local ecosystems and environment, increased quality of life in the community, and deeper understanding of the design requirements for ecological sustainability in coastal towns such as Lennox Head.

Through sustainable development practices, the ecological value of Lennox Head and its surrounding environment is increased. Over time, up to 1.55 kilometers of degraded dunes along Lennox Head will be restored. Furthermore, by diverting stormwater runoff from the storm drain system, green infrastructure reduces runoff that typically flows across and erodes Seven Mile Beach. Both dune restoration and stormwater management help stabilize Seven Mile Beach, preserving the beach culture that plays an integral role in the community. The sensitive ecology of Lake Ainsworth as a freshwater coastal lake has also been strengthened, ensuring the longevity of its unique environmental value.

In addition to the ecological value of the proposal, the redevelopment of Lennox Head enhances the community's value and quality of life. The conservation and restoration at Lake Ainsworth protects continued public use as well as the lake's ecological value. The incorporation of natural landscapes into the village also has several direct benefits for the community. Increased tree and other vegetative cover not only increase the community's aesthetic value but also sociability. Moreover, it improves air quality and reduces ambient street temperature, which is especially important during Lennox Head's hot summer months.

Small scale urban agriculture provides fresh food to local businesses and residents. The environmental resource center and eco-revelatory paths facilitate public education about the environment near Lake Ainsworth in order to stimulate social interaction and community well-being further. Also, the integration of the planned regional bike network into the community provides a mode of reaching the neighboring towns of Skennars Head, Ballina, and Byron Bay without a personal motor vehicle while also experiencing the countryside and coast.

The implications of this project extend beyond its direct physical benefits to Lennox Head. It leads to a better understanding in the field of landscape architecture about ecological sustainability in coastal villages. This context is especially important in Australia, as 84.7% of the population lives within 50 kilometers (31 miles) of the coast. The strategy of integrating people and nature on both a physical and social level can serve as a framework for similar communities both in Australia and around the world. Layering scales of land-use planning, ecological restoration, green infrastructure networks, and social programming is a compelling approach to ecological sustainability in the context of a coastal village community with a history of beach erosion, dune loss, and sensitive inland habitats.

[Goals]

Simply fixing the symptoms dune erosion, habitat loss, and water quality will not in the end create a successful, healthy landscape. A focus must be placed on the underlying problems that have led to the major ecological issues. Thus, the major goals of the project reflect a necessary framework for a holistic solution. As a result, two major aspects of integrating build and natural systems must be addressed: the physical aspect of developing new networks and the social aspect of creating new perceptions. Goals that stem from the physical side include integrating land use to stimulate both ecological and societal needs, redefining the transportation network to lower the impact of streets and vehicles, and encouraging adaptive environments to increase the resiliency and health of both town and environment. On the social side, goals include interaction with ecological habitats, public education, and direct benefits from the landscape. Many of these goals and objectives are interconnected, sharing similar purposes or design outcomes. Figure 2.8 illustrates the links between different goals and objectives.

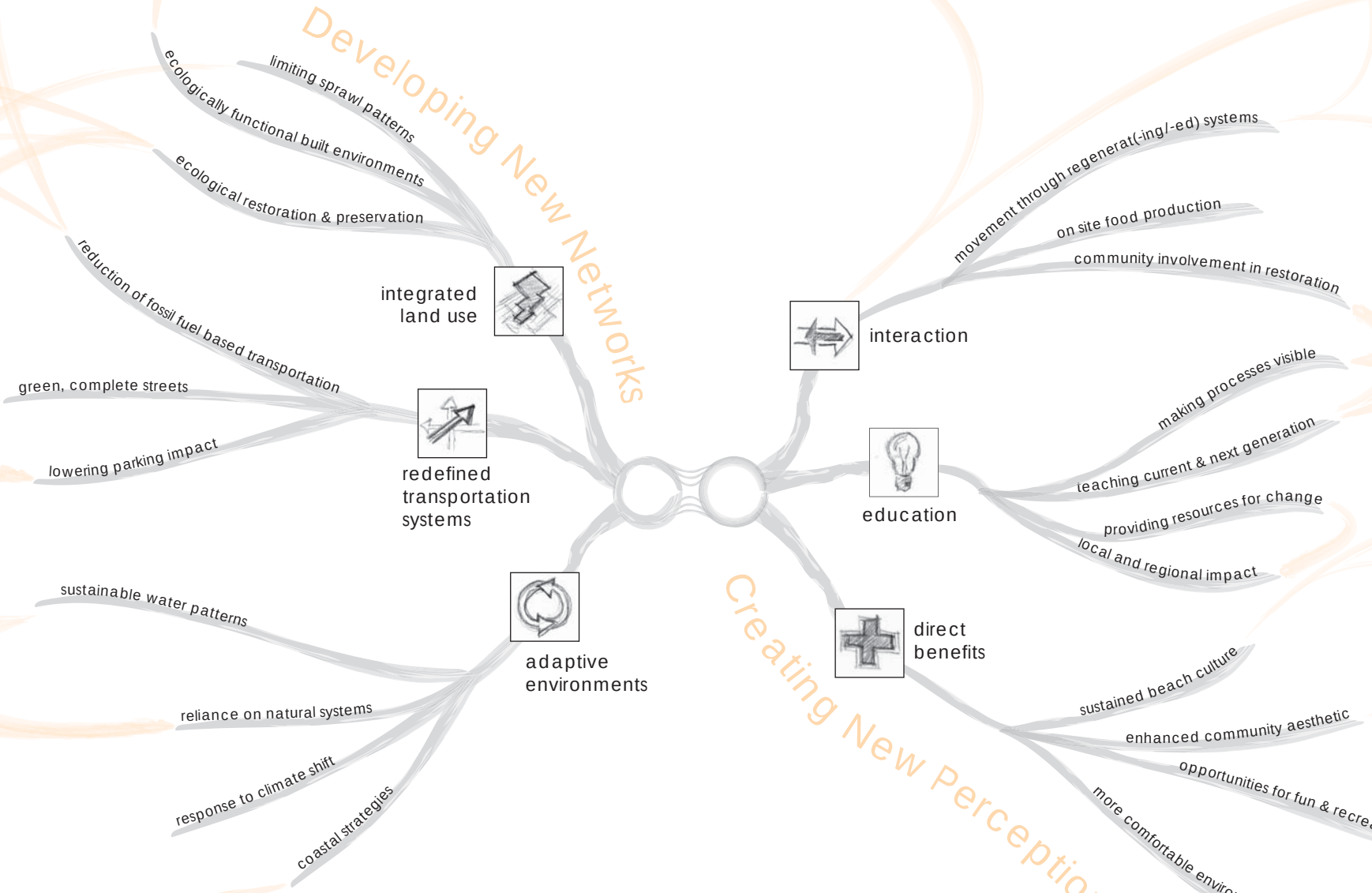


Figure 2.8 Goals & Objectives

[Program]

Integrated Land Use

- Limiting Sprawl Patterns

  Denser Development: New growth encourages medium density residential (30-40 units/ha) over standard low density (10-15 units/ha) development to achieve the projected growth in as little greenfield development as possible. Medium density neighborhoods are preferentially sited close to important town amenities, such as the beach and commercial districts.

  Infill: The town will implement a strategy of infill development. This measure entails acquiring residential land in low density areas, especially along the beachfront, when it becomes available. This land will then be upgraded to medium density development.

  Growth Boundaries: To prevent any further sprawl, growth boundaries are placed around the proposed land use. Future town growth will have to occur through densification.

- Ecologically Functioning Built Environments

  Native Landscaping: Residential ordinances will heavily encourage the use of native plants and actively discourage manicured lawn in order to create spaces around homes that provide ecological value to native flora and fauna. Native landscaping will also be encouraged in public spaces such as parks, open spaces, and streetscapes.

  Green Roofs: On new commercial, public, and medium density buildings, green roofs will be implemented to help slow down water and provide habitat on an otherwise impervious surface.

- Ecological Restoration and Preservation

  Dune Restoration: Restoration efforts on Seven Mile Beach utilize dune forming fences (see Figure A.5) to rebuild lost dunes. Indigenous plantings (see Figure B.1) help stabilize the dunes, reducing the chance of continued erosion. For continued dune health, it is imperative to keep people off of the dunes, so signage and protective fencing (see Figure A.6) would be installed where necessary. At the moment, the effectiveness of these actions is uncertain because the sand supply is blocked updrift at the Richmond River training walls. Eventually, however, the littoral drift patterns should return to normal as the beach around the training walls stabilize.

  Littoral Rainforest Restoration: Traditional tertiary dune vegetation (i.e. littoral rainforest habitat) is restored between the town and the beach from the revetment through Lake Ainsworth.

  Lake Preservation: Lake Ainsworth is preserved by removing many of the detrimental societal influences, including two roads and stormwater pipes. The shores are replanted with historic Typha communities, which protect both the shore and water quality.

Redefined Transportation Systems

- Reduction of Fossil Fuel Based Transportation: Capitalizing on

the existing regional bus system, a multi-modal transportation network is created that connects a shuttle system, bike paths, and pedestrian walkability.

- Green, Complete Streets: Streets support increased levels of vegetation including street trees, bioretention gardens, and other native plantings. These provide a more comfortable and aesthetic experience in addition to their ecological benefits. They also provide adequate space for bike use, on-street parking, and sidewalks.

- Lowering Parking Impact: The impact of parking on the environment is lowered through the reduction of land coverage and responsible stormwater management. Non-automobile transportation is encouraged, and a parking structure provides more spaces for less area. Runoff is treated through pervious paving or bioretention gardens.

Adaptive Environments

- Sustainable Water Patterns

  Stormwater Management: New development handles stormwater as much stormwater as possible before sending it to a drain. Strategies for this include bioretention infiltration, pervious pavement, and bioswale filtration. Retrofits will be gradually made to the existing town.

  Wastewater Treatment & Reuse: At the site of the current wastewater treatment plant, a recycled water treatment plant is added. Instead of releasing treated wastewater into the Richmond River, this plant cleans treated wastewater again, allowing it to be used in greywater applications such as irrigation and toilet flushing. By reusing this water, it reduces the amount of potable water used by the community.

  Watershed Management: Stormwater management will be dealt with not just at the site scale but on the regional scale as well. This primarily involves restoring natural catchment areas, utilizing best management practices to clean water.

- Reliance on Natural Systems

  Energy: New development pays attention to passive systems, utilizing cooling winds, day lighting, and solar panels on buildings. Trees also are placed on the north and west side of buildings to reduce the energy used in cooling buildings.

  Materials: Materials are renewable and locally sourced as much as possible. New buildings and landscape elements will be designed for deconstruction so that individual pieces can be reused thereby reducing the need for virgin materials.

- Coastal Strategies

  Dynamic Dune Systems: Rejecting a seawall approach to coastal protection, the restoration of the dunes creates a dynamic system that can respond to the various factors influencing it, improving the town's resiliency.

  Strategic Retreat: A policy of strategic retreat should be implemented to give room for the coast to shift naturally inland. This retreat gives natural systems enough space to work as they should, providing all the protection and benefits of a healthy coastline.

- Response to Climate Shift

  Water Conservation: Collected stormwater and cleaned wastewater use will reduce potable water in situations greywater can be used, like irrigation and toilet flushing. Reducing the need for irrigation by reducing lawn and increasing the use of drought tolerant plants is also important.

  Capacity to Handle Flooding: Restoration of the dunes creates a natural system through which the town has a greater capacity to handle flooding. Furthermore, by decentralizing stormwater management through green infrastructure, the potential for heavy flooding will be reduced.

Interaction with Nature

- Movement through Regenerated Ecosystems: A number of paths throughout the town allow people to interact with the renewed natural systems in the town. Some of these paths include the regional bike path, dune crossings, and the lake shore.

- Community Involvement in Restoration: Efforts with installing dune forming fences and replanting dunes and around the lake will call for volunteers to help. This level of involvement will foster community pride in the restoration efforts.

- Food Production

  Community Gardens: Small gardens throughout the community produce food that can be sold to either local restaurants or at the local market, allowing people to rely more on the local land.

  Individual Food Production: Resources are provided at the Environmental Resource Center to help residents produce food on their own land.

Environmental Education

- Making Processes Visible

  Ecorevelatory Poles: A series of poles extending from the beach inland at different points in the town allows residents to see the shift in the dunes over time, both from natural processes and restoration efforts.

  Signage: At specific points around Lake Ainsworth and the Surf Life Saving Club, signs discuss the process of restoration and the function of green infrastructure, as well as the necessity of both.

- Teaching Current and Next Generation: The Environmental Resource Center hosts space for classes which can be used for fixed and rotating exhibits, in addition to classroom space. A number of points near the center also serve as educational tools.

- Providing Resources for Change: The Environmental Resource Center has a wealth of knowledge that can be distributed to people interested in learning more about restoration and sustainability.

- Local and Regional Impact: Because of the proximity of the Caravan Park to the Environmental Resource Center, the center has the ability to have both local and regional impact.

Direct Landscape Benefits

- Sustained Beach Culture: Protection of the beach through dune restoration helps ensure the survival of Seven Mile Beach, which has a strong cultural influence on the town.

- Enhanced Community Aesthetic: The increase in vegetation cover through tree lined streets, bioretention gardens, and other native plantings increases the general aesthetic of the town. In addition, the site of the Surf Life Saving Club is visually improved.

- Opportunities for Fun and Recreation

  Paths for Recreation: A network of paths around the town allows residents not only the chance to get from place to place, but also bike, run, or hike recreationally.

  Public Spaces: Important public social spaces including the beach, surf club lawn, and lake shore are preserved in order to capitalize upon the existing social strength of the site.

- More Comfortable Environments

  Cooler Microclimates: Streets and public spaces are lined on the north and west sides with trees to provide shade for pedestrians.

  Buffers: One to two meters typically separate sidewalks from streets with vegetation planted in between them to create a sense of safety.

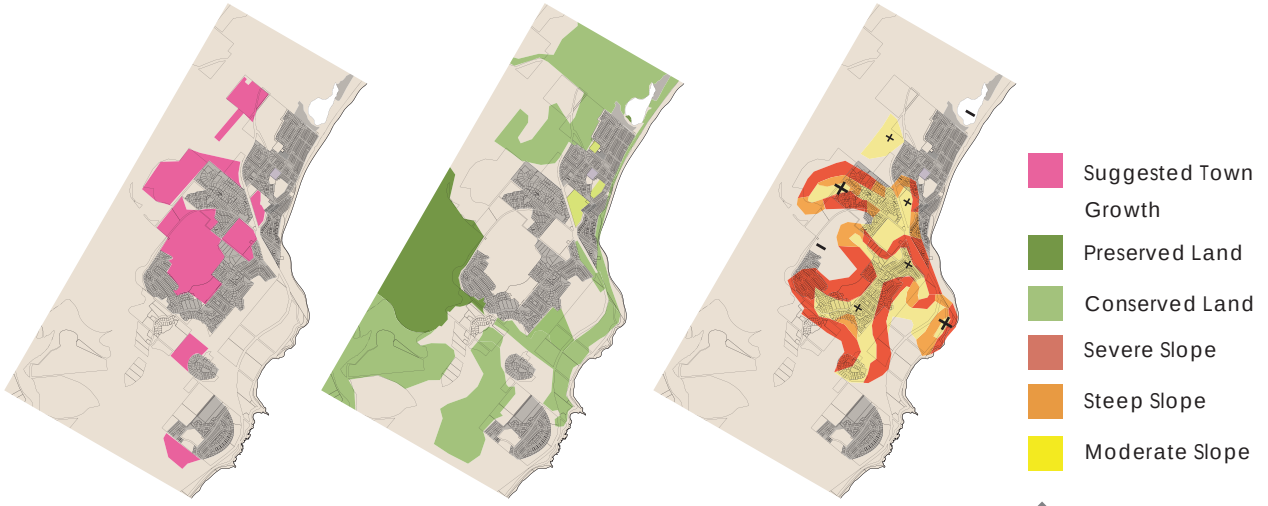
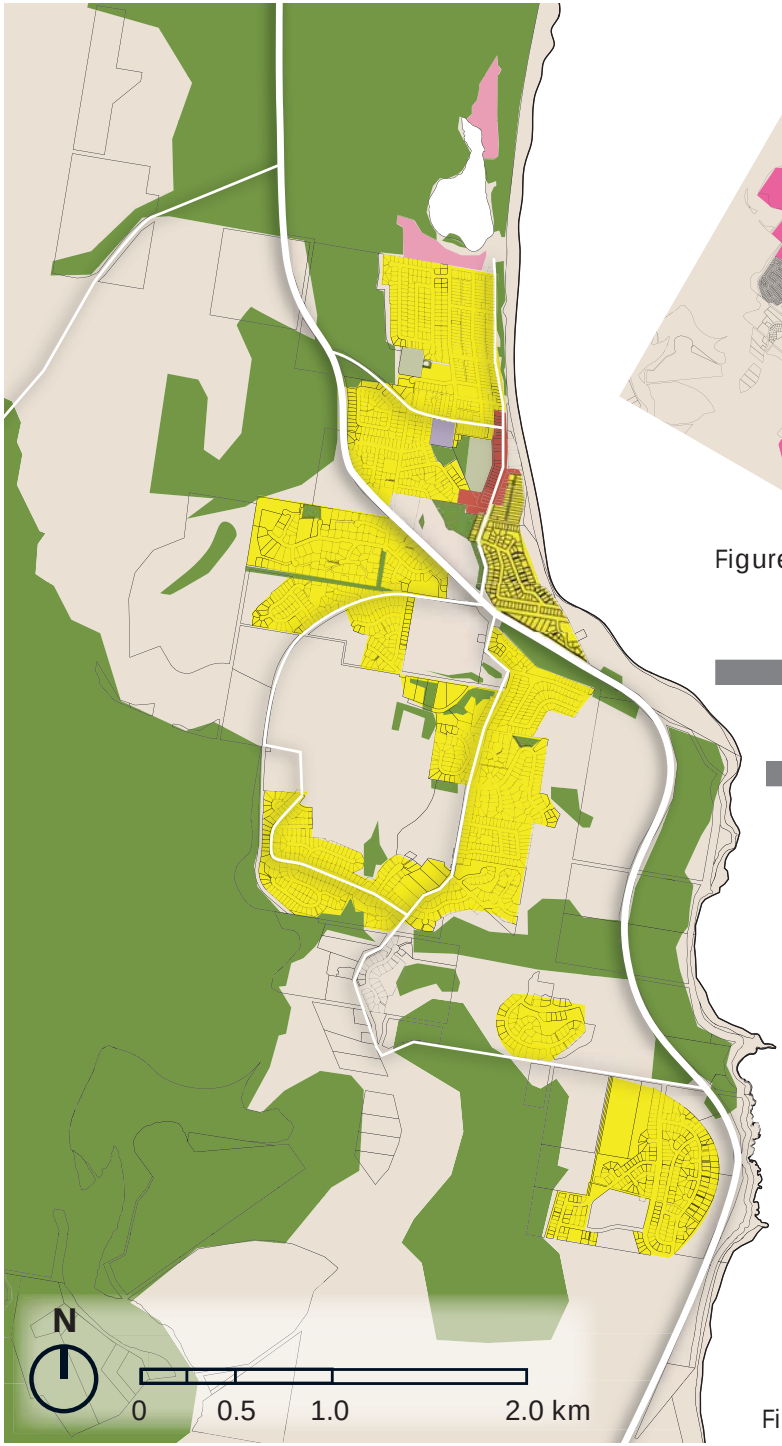


Figure 3.1 Opportunities & Constraints

Integrated Land Use



- Habitat
- Low Density Residential (10-15 units/ha)
- Medium Density Residential (30-40 units/ha)
- Commerical District
- Other Use
- Existing Town Infrastructure

Figure 3.2 Existing Land Use

[Existing Conditions]

The town is marked by low density and primarily residential development (Figure 3.2). On the south side of the town, development remains relatively compact due to the physical limitations of the ocean and conserved land. South, on the other hand, the town begins to show signs of sprawl. This part of the town is restricted mainly by steep slopes, some of which have already been built upon (Figure 3.1).

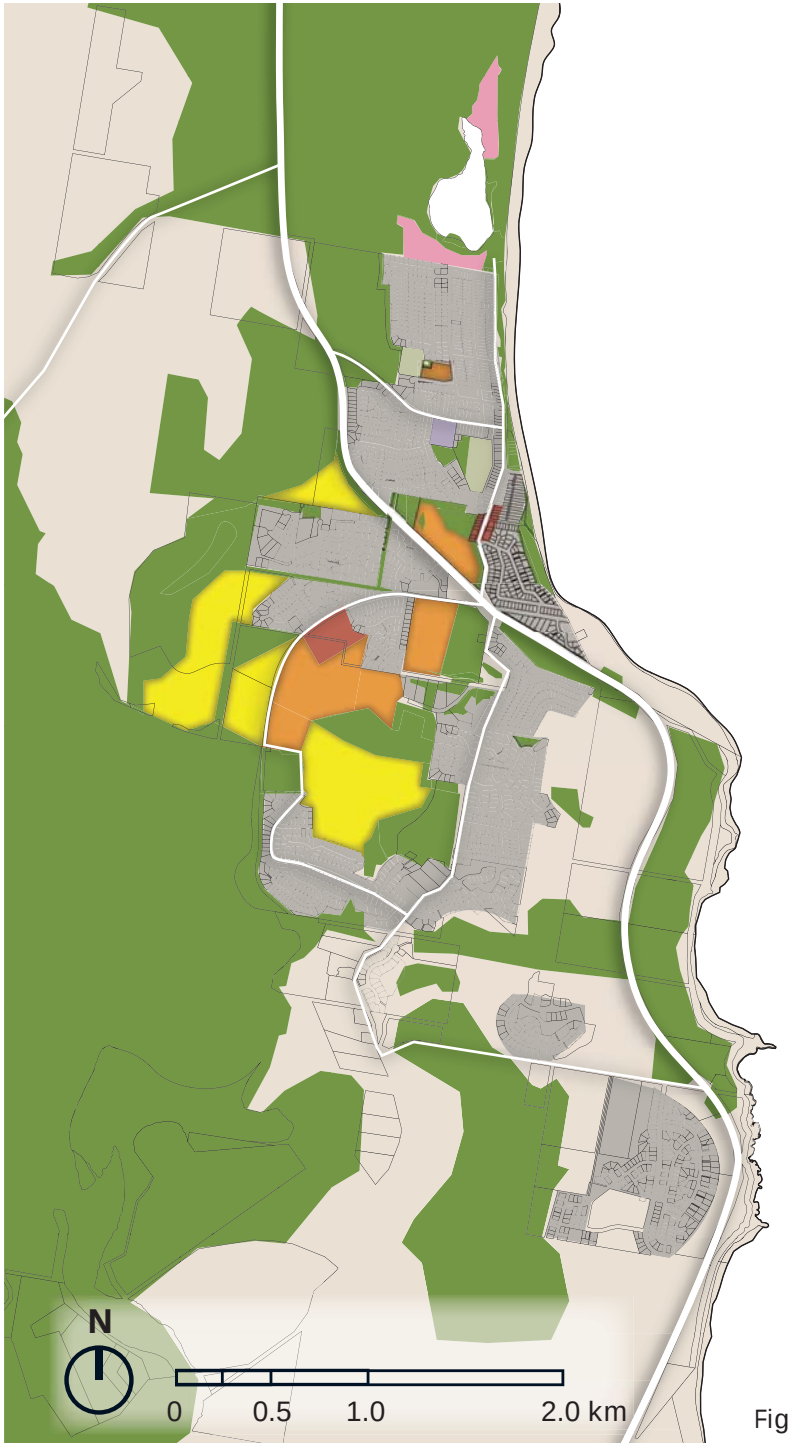


Figure 3.3 Town Growth

[Proposed Growth Patterns]

To meet the town's expected growth of 4,850 residents (67%) at current trends would require an additional 207.1 ha of land. To reduce this footprint, new development (Figure 3.3) consists of a majority of medium density residential units. This limits sprawl, reducing land development to only an additional 104.6 ha while yielding a capacity of over 5,000 people. This yield reduces greenfield development by over half. A secondary commercial center is created in the part of the town south of the Coastal Road to localize residents' needs.

The smaller footprint helps also with integrating ecological communities and the town by leaving gaps for habitat to weave its way into Lennox Head. These restoration sites were chosen to protect important geographic features, including lowlands and steep slopes. These patches are linked by narrow corridors to the surrounding habitat, improving the biodiversity of the region. To further strengthen the ecology of the region, residential areas shift away from the use of manicured lawn and exotic landscaping. The resulting native landscapes create a unified fabric of ecological function throughout the community (Figure 3.4).

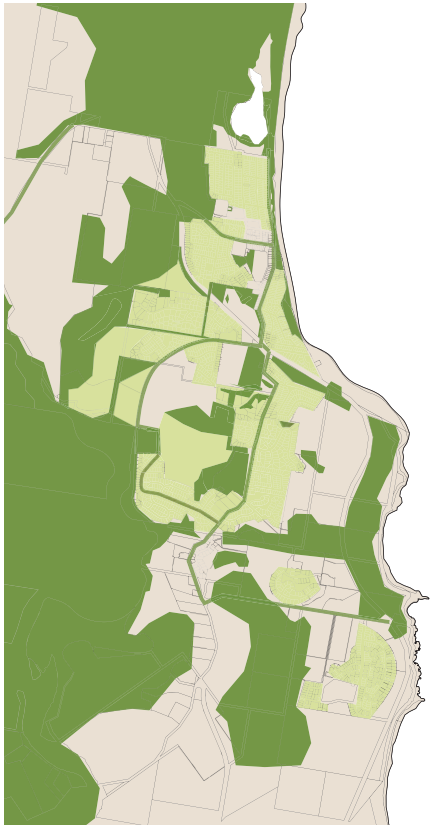
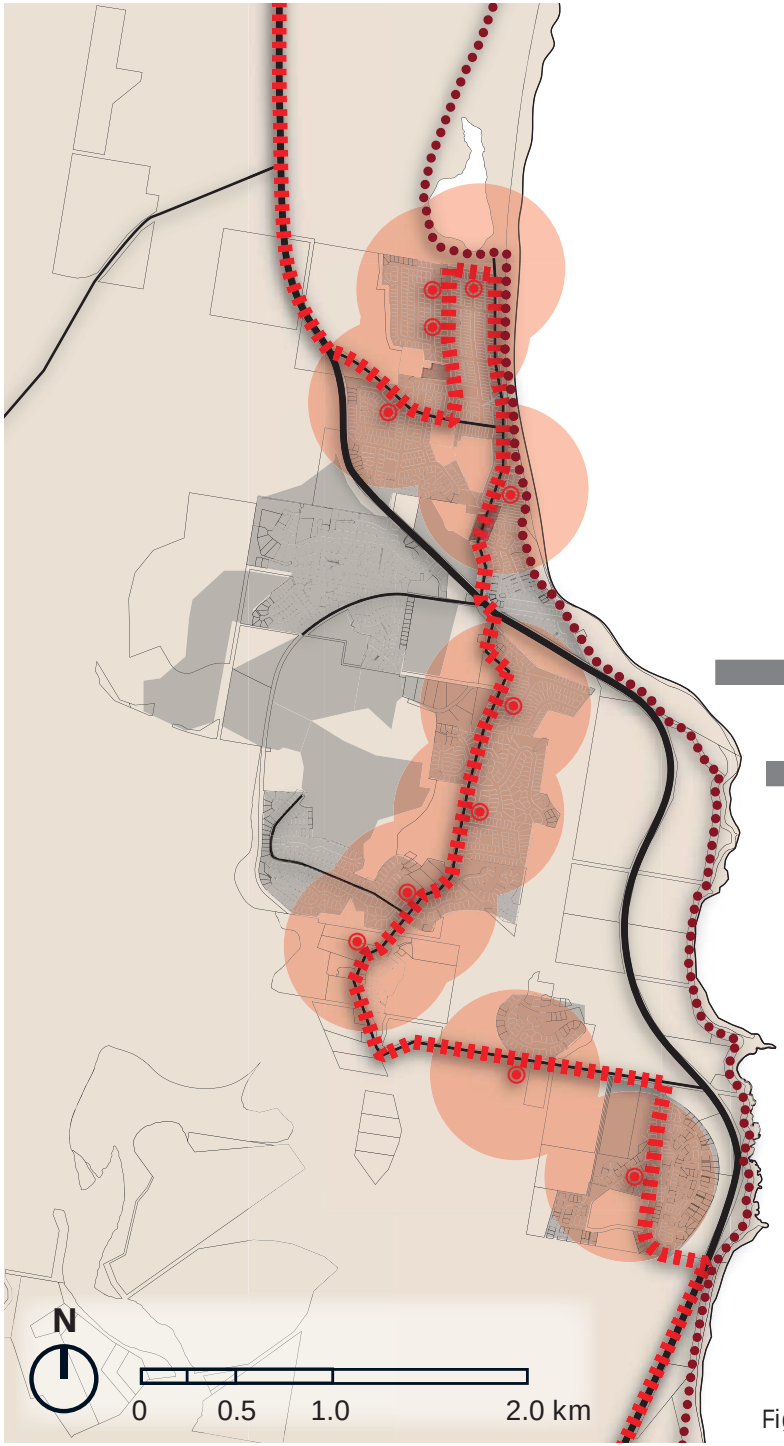


Figure 3.4 Ecologically Beneficial Landscapes



[Existing Conditions]

Residents, especially those south of the Coast Road, rely heavily on personal automobiles to get both around the village and to nearby towns. A regional bus route connecting Ballina and Byron Bay does run through the town. It provides easily walkable service for part of the town, excepting a large region to the west. A plan has also been established to create a regional bike route along the coast (Figure 3.5). Aside from a few sidewalks on the main road along the beach, however, pedestrian infrastructure in Lennox Head is virtually non-existent.

Redefined Transportation Systems

- Regional Road
- Local Road
- Proposed Regional Bikeway
- Pedestrian/Bike Trailway
- Bus Route
- Bus Stop
- Shuttle Stop
- 5 Minute Walk to Bus Stop

Figure 3.5 Existing Transportation in Lennox Head

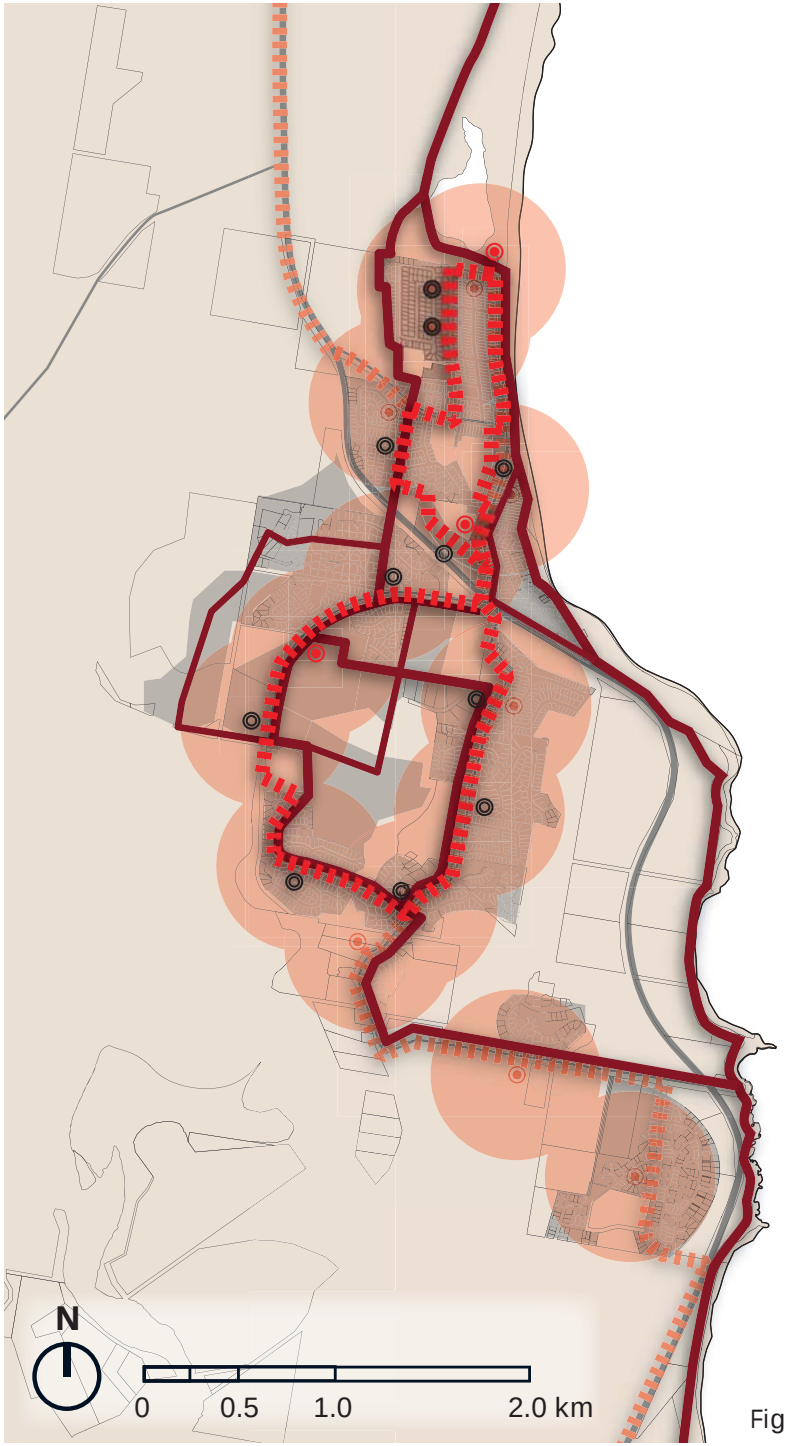
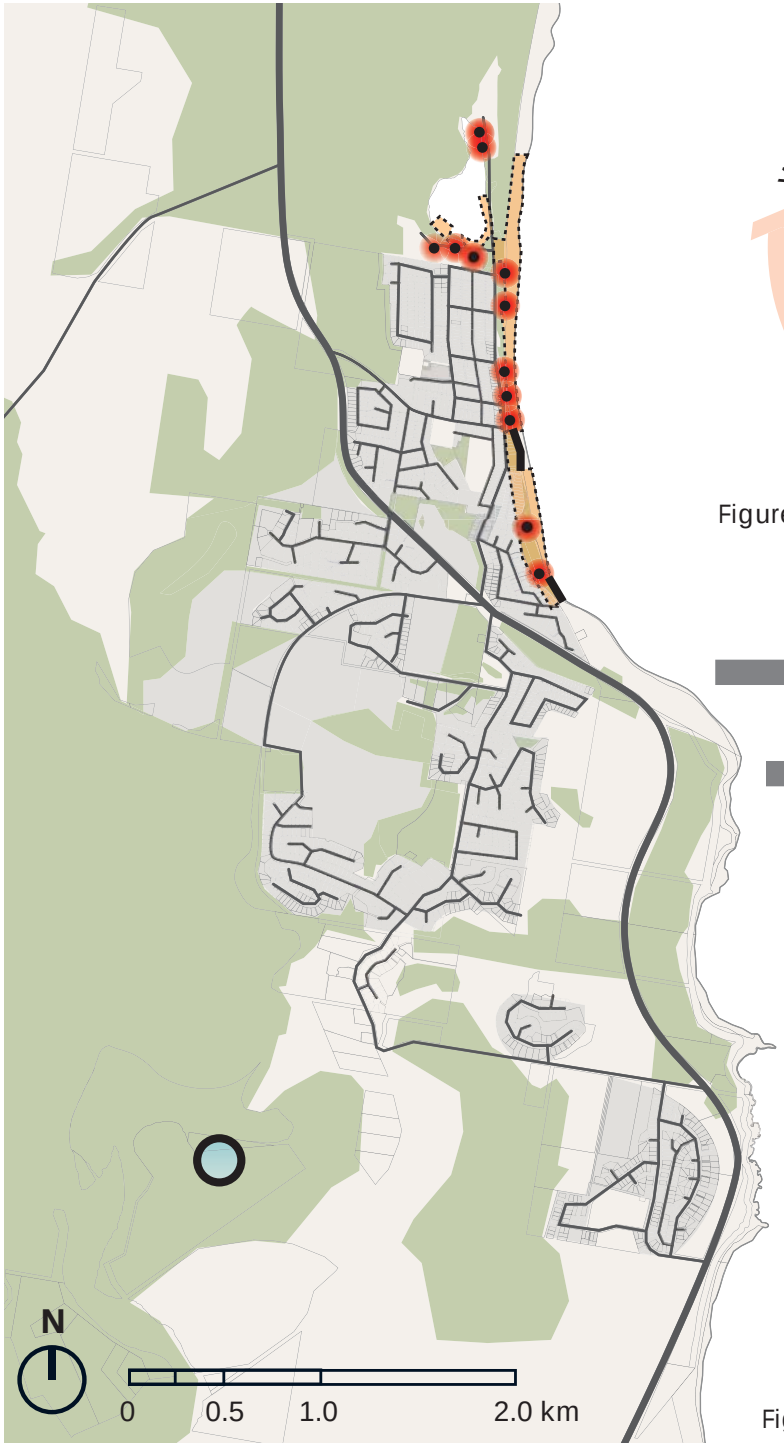


Figure 3.6 Expansion of Transportation Network

[Proposed Growth Patterns]

Changes in transportation systems deal primarily with reducing the need for personal vehicles, lowering consumption of fossil fuels, and decreasing parking needs (Figure 3.6). As a result, an in-town shuttle runs at times of high need like commute hours, weekends, and holidays. Near the existing town center, a parking structure is created to decrease land devoted to parking. The shuttle stops there, making it convenient for people from out of town to get to the beach.

A series of looped paths throughout the town allows residents to bike or walk easily to a bus stop, the store, or the beach. They also provide excellent opportunities for exercise and scenic walks. Furthermore, existing bus stops are upgraded to encourage multi-modal transit by including bike racks. This system allows people far from a bus stop to reach one easily.



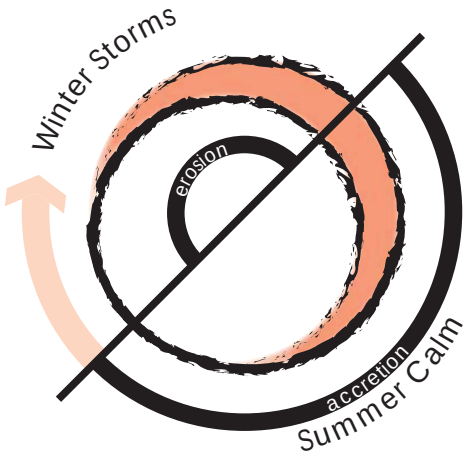


Figure 3.7 Natural Accretion/Erosion Cycle

ADAPTIVE ENVIRONMENTS

Constructed Seawall

Stormwater Drain

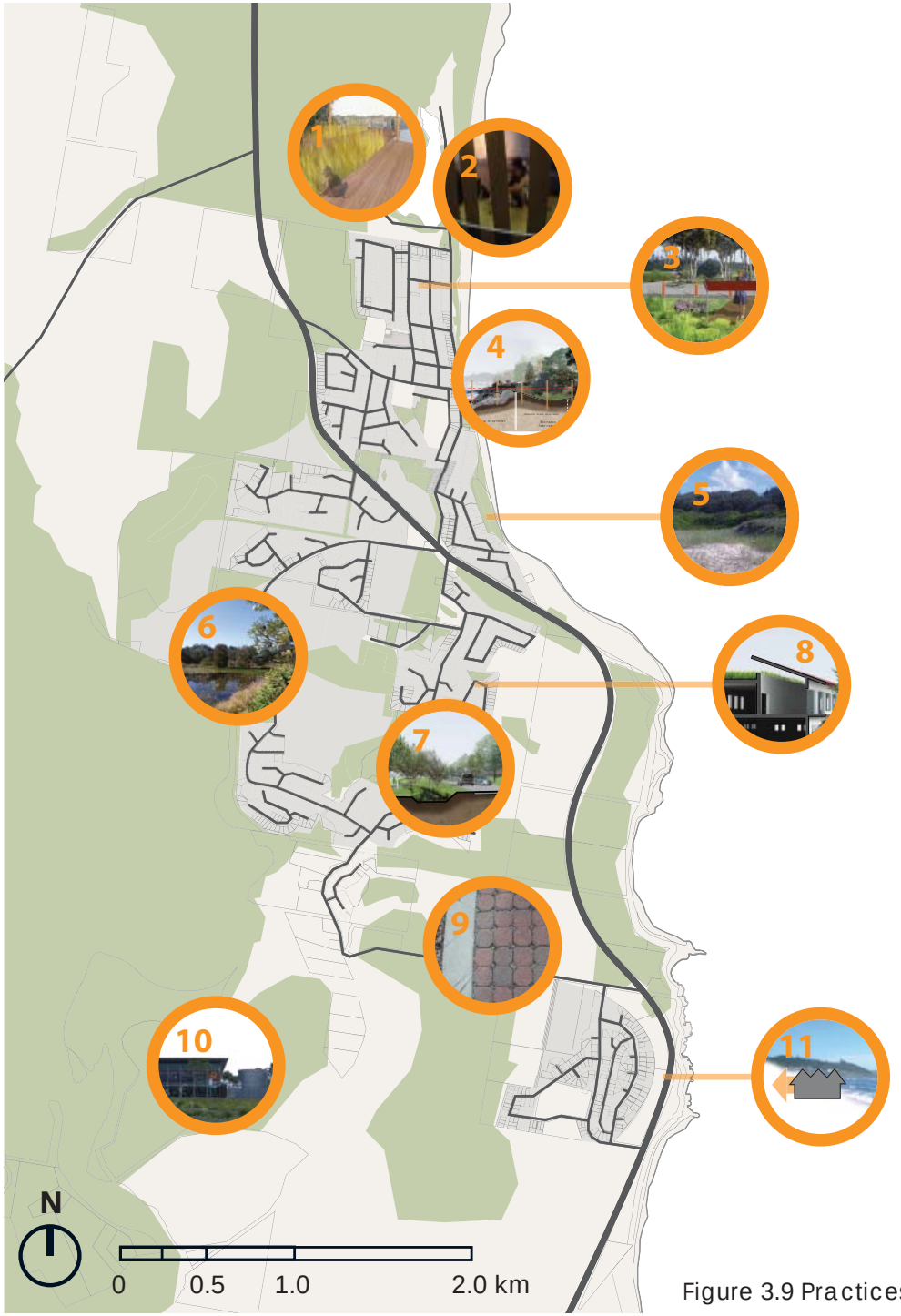
Wastewater Treatment Plant

Erosion

Figure 3.8 Ecological Issues

[Existing Conditions]

The coastline is the location of most of the issues the town faces. The beach is eroding, due in part to the natural cycle of dune erosion/accretion being interrupted by the training wall at the Richmond River up littoral drift (Figure 3.7). Furthermore, stormwater is piped to drains that empty over the beach and the lake, exacerbating erosion. Several seawalls also increase erosion down the beach (Figure 3.8).



[Proposed Growth Patterns]

The town seeks to create not only healthy but also adaptive environments that can resiliently respond to environmental changes, such as coastline recession, flooding, and drought.

Along the coast, a healthy dune sequence is reestablished through dune forming fences & plantings, the restoration of tertiary vegetation, and strategic retreat along the coast.

Instead of sending stormwater straight to a pipe, BMPs such as bioswale filtration, bioretention, pervious paving, and green roofs slow down water and reduce the amount entering pipes. This not only reduces erosion caused by outflow from the drains but also decreases pressure on infrastructure during heavy rain events.

Using a reservoir to store filtered stormwater and cleaned wastewater will also reduce the town's consumption of potable water for irrigation and toilet flushing. The use of recycled water will help the town be resilient through periods of drought (Figure 3.9).

1 Shore revegetation
2 Dune regrowth
3 Bioswale filtration
4 Revetment reduction
5 Reestablished coastal vegetation
6 Recycled water reservoir
7 Street bioretention
8 Green roofs
9 Pervious pavement
10 Recycled water treatment plant
11 Strategic Retreat

Figure 3.9 Practices for Adaptive Environments

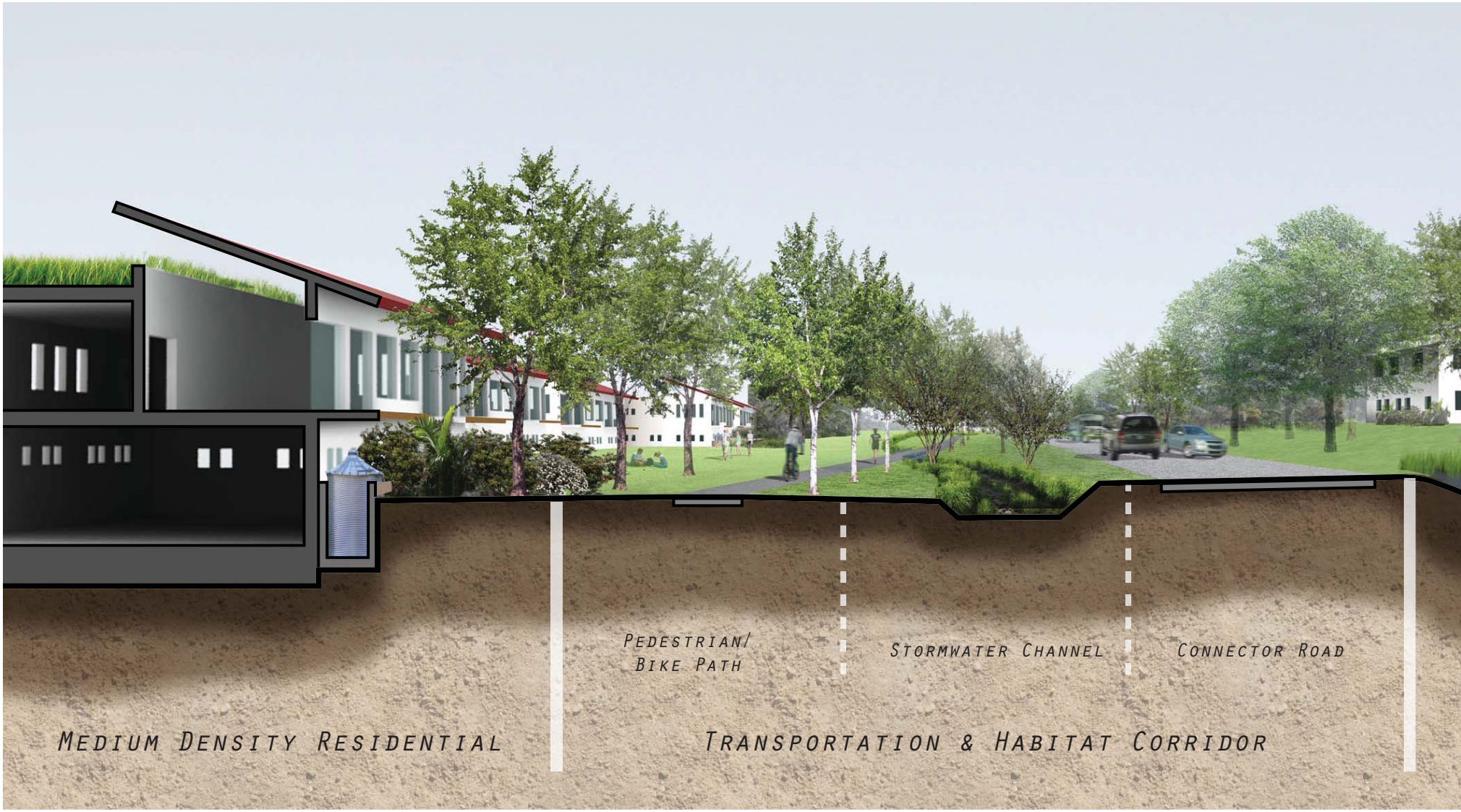


Figure 3.10 Section of Typical New Development

0 2.0 5.0 10.0 m

[New Development]

Figure 3.10 illustrates the relationship between medium density housing, low density housing, and the transportation corridor. The street right of way becomes a place that facilitates multiple systems including vehicular, bike, pedestrian, water, and habitat. The pedestrian/bike path is separated from the road to provide proper scale and strengthen its connection to the medium density housing. Pockets open up in the housing to create open spaces for residences along the corridor. Canopy cover is essential to the spatial definition of the corridor, creating both openness and enclosure. The water system creates a complex relationship with the street. Crossing under the street where necessary, the water channel collects stormwater from the road and path, conveying it to the town reservoir.

[The Revetment]

While the main revetment in town does prevent shoreline recession, it aggravates erosion farther down the beach. Entirely removing the revetment is unfeasible because high tide already touches the base of it. Removal would then only accomplish catastrophic erosion. Only the base of the revetment, however, is needed to protect the beach. To encourage natural systems, the upper half is removed and replaced with secondary and tertiary dune vegetation. This restoration improves the town's resiliency to large storm events while still protecting the shore. The regional bike path would travel over the seam between revetment and natural systems, creating a visual dichotomy between the two.

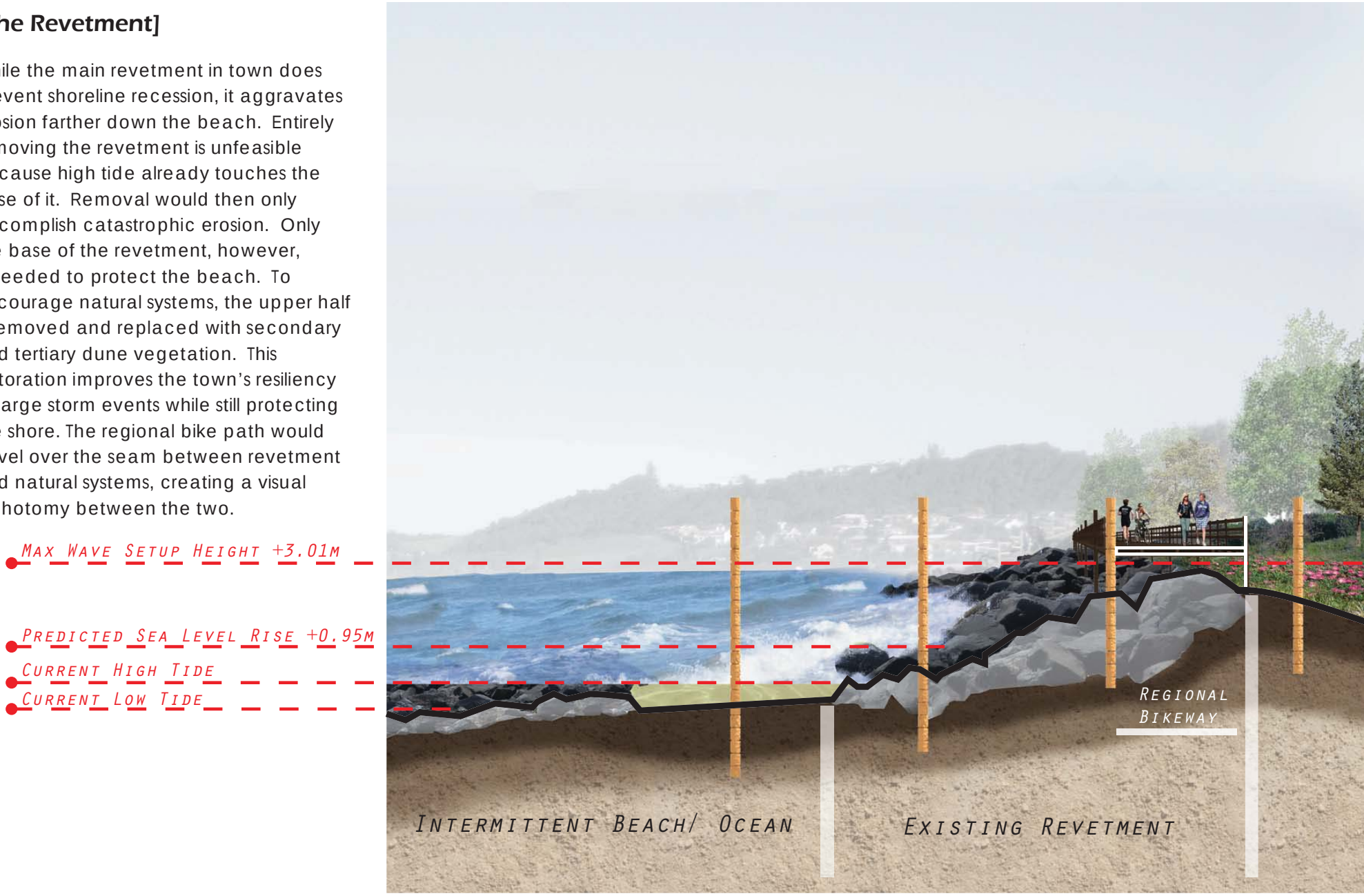


Figure 3.11 Section of Changes to Town Revetment


Removed Upper Revetment
Ceded Park Land
Restored Secondary and Tertiary Dune Vegetation
Existing Community Park

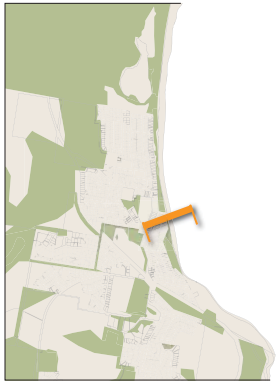


Figure 3.12 Locations of Ecorevelatory Pole Lines

[Ecorevelatory Design]

Previous discussion has focused on the physical aspect of integrating ecological and built communities. Social perception, however, is equally important. A series of ecorevelatory installations throughout the town makes people aware of the natural coastal processes in their everyday environment, specifically the shift in dunes from both natural and manmade factors. These installations are a line of wooden poles which extend from the beach inland (see Figure 3.11). They reveal the change in topography between the beach and the town. Six sets are located throughout the town. These locations are near important dune crossings, especially at the Sport and Recreation Camp, the Surf Life Saving Club, and the revetment (Figure 3.12).

Making Processes Visible

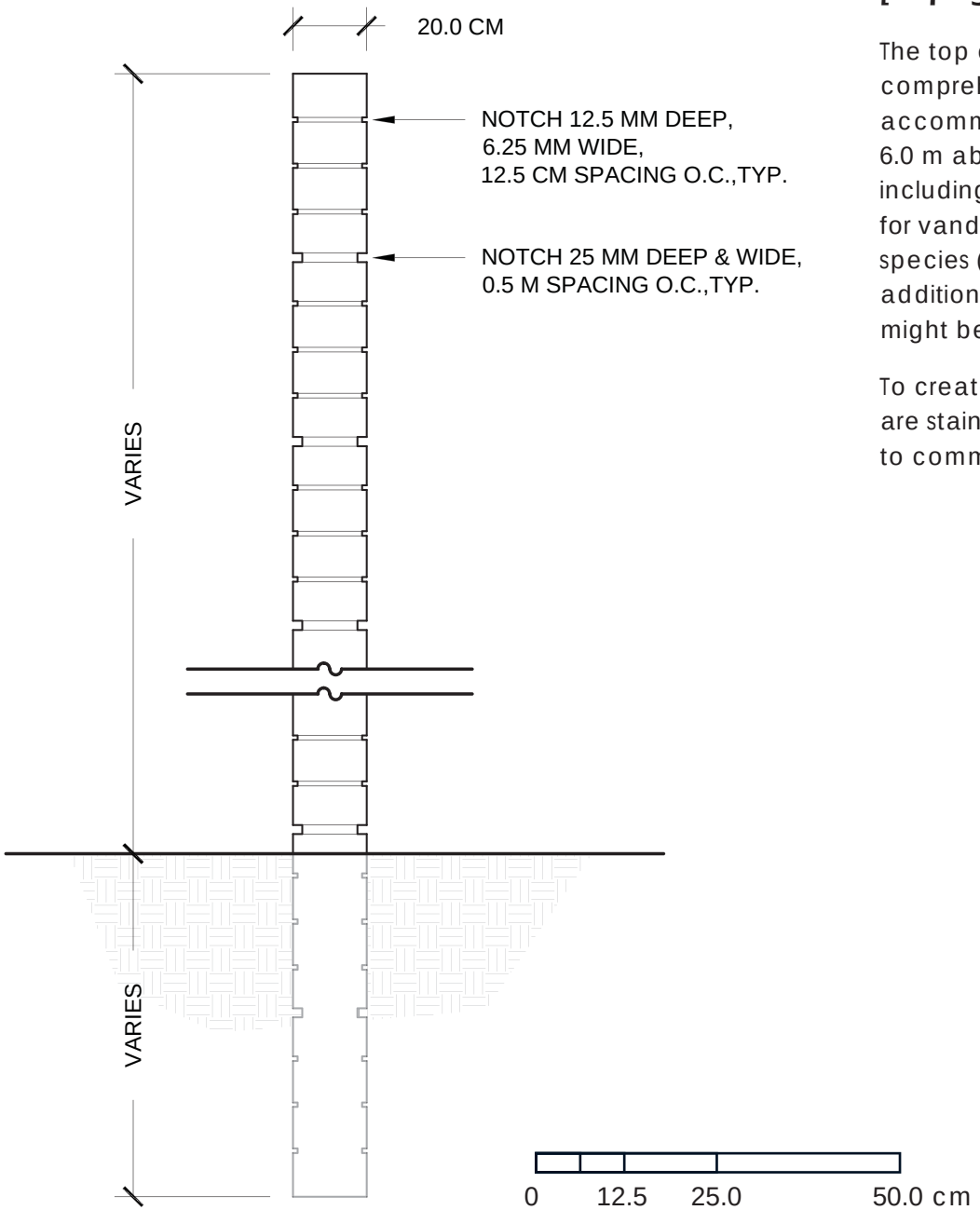


Figure 3.13 Detail of Wooden Pole

[Topography Revealing Poles]

The top elevation of each pole is the same, allowing people to comprehend visually the topographic change along the coast. To accommodate the local topography, pole heights range from 1.0 m to 6.0 m above grade. Below grade depends on subsurface conditions including soil, saturation, and cultural conditions such as the potential for vandalism (Figure 3.13). The poles are sourced from local Ironbark species (*Eucalyptus spp.*) which are naturally decay resistant. If an additional preservative is needed, however, treatments with linseed oil might be acceptable.

To create a stronger visual statement in the landscape, the wood poles are stained a soft orange. Deep notches alternate with thinner notches to communicate the precise grade change on a pole.

Figure 4.1 Site Context

Figure 4.2 Site Conditions

[Focus Site Inventory]

Because of its high ecological and social value, the area around the Surf Life Saving Club was selected to serve as a model for the rest of the community. The site is nestled between a coastal freshwater lake and the ocean (Figure 4.1). Historically, it hosts a wide range of different habitats due to the quick transition from beach, to dunes, to lake. The site also demonstrates many of the ecological issues the town is facing, including dune erosion, loss of littoral rainforest habitat, and poor water quality.

The site furthermore is one of the most publicly active places in town. Due to the presence of the surf club, many people use the beach here. The southern shores of the lake are also extremely popular. All this activity is increased by the Caravan Park's presence just west of the site (Figure 4.2).

Figure 4.3 South Shore of the Lake

Figure 4.4 View West from Surf Club

Figure 4.5 Surf Club from Beach

Hydrology

- Polluted runoff from roads and caravan park enter lake.
- Stormwater drains dump polluted runoff from town into lake.

Ecology

- Continuity of dune habitat is broken by pedestrian crossings.
- Natural sequence from dunes to inland vegetation is gone.
- Small inland patches are disconnected from each other.
- Historic *Typha* communities from lake edge are gone.

Vehicular Circulation

- Roads along lake contribute polluted runoff and increase shore erosion.
- Roads provide high levels of parking during peak use [140+ vehicles].
- Pacific Parade connects only to Sport and Recreation Center.

Pedestrian Flow

- Many pedestrian spaces and paths on site are unplanned.
- Main corridor from town is beach.
- Connection to the neighboring residential area is weak.
- Beach, surf club green, and lake shore are the three main public spaces.

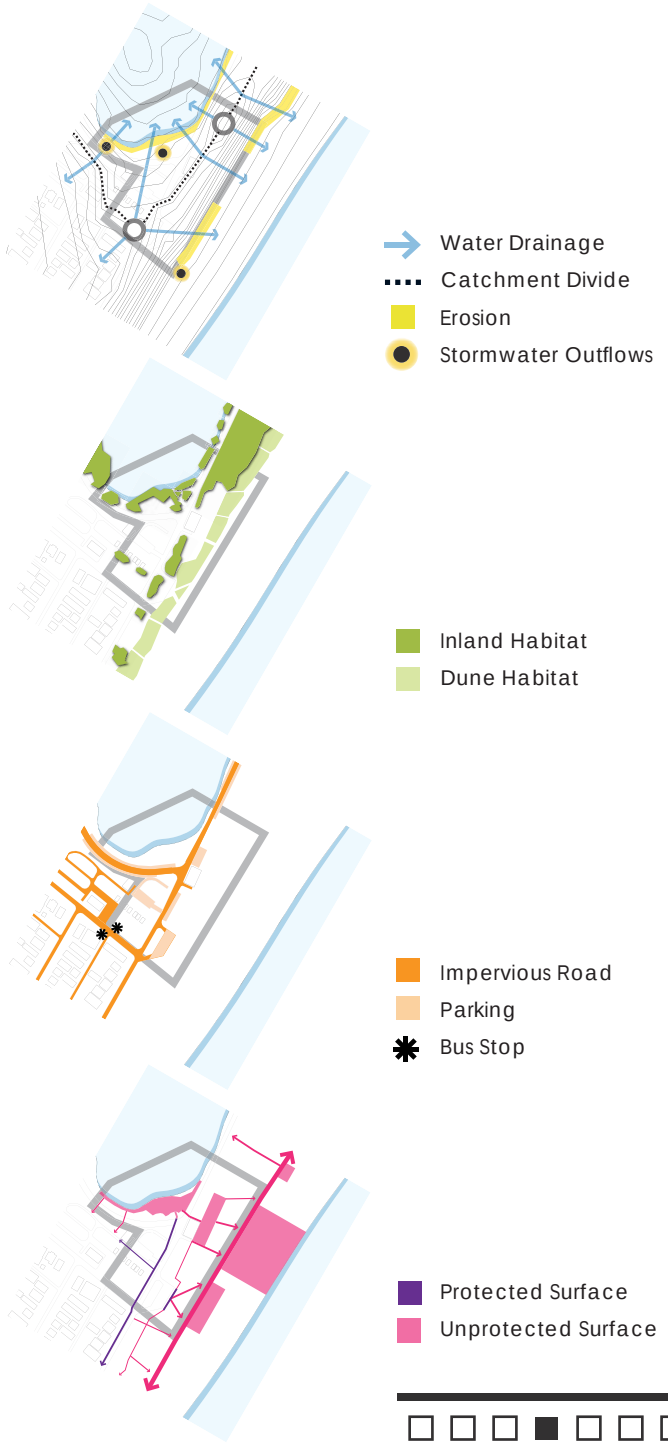


Figure 4.6 Site Layers

[Preliminary Concepts]

The design for the site plan was developed through a set of alternative concepts (Figures 4.8-10) based on an initial concept (Figure 4.7). Each concept addressed site issues with slightly different solutions. The different vantage points highlighted the weak and strong elements in each concept, which allowed for a synthesis of the strongest ideas for the final site plan.

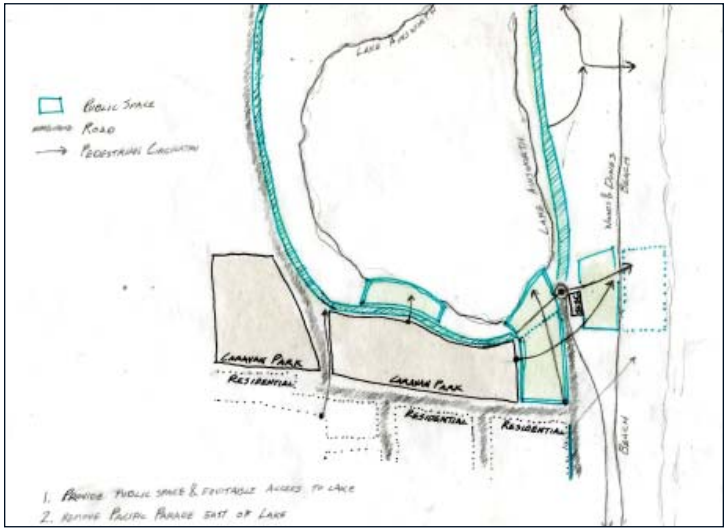


Figure 4.7 Initial Sketched Concept

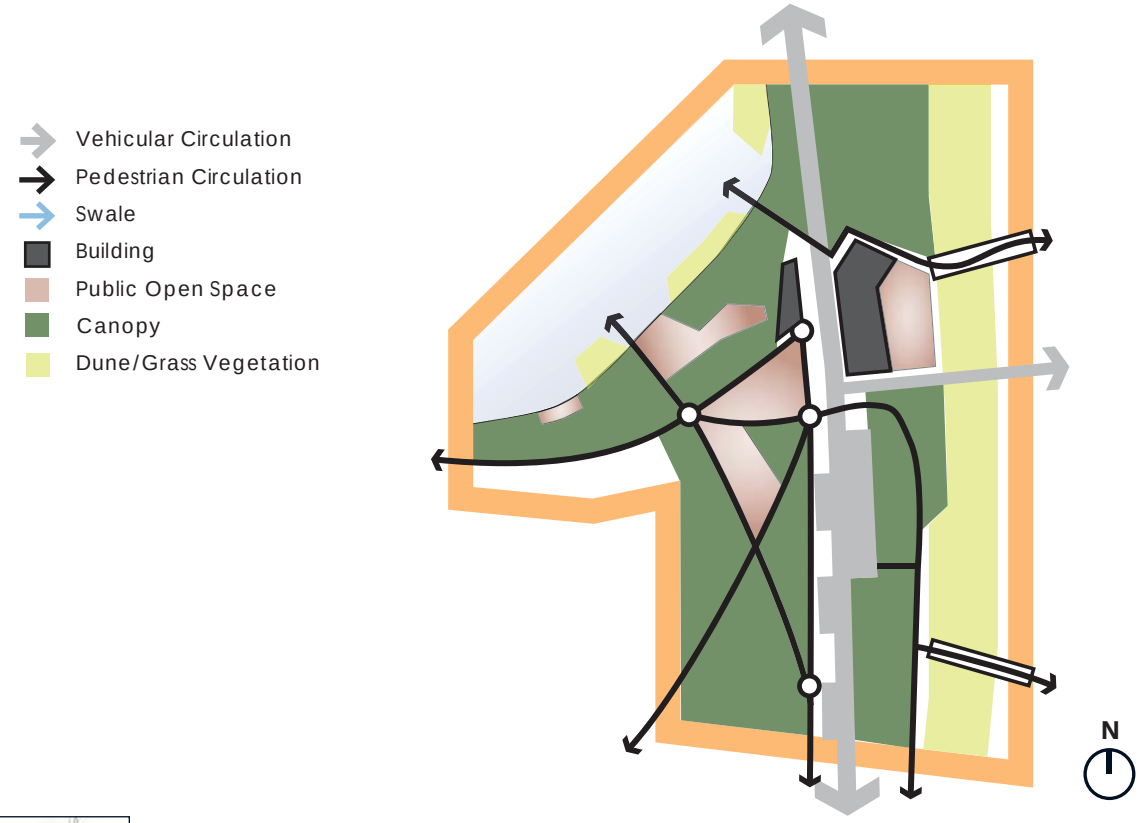


Figure 4.8 Concept Alpha

This alternative was primarily focused on a limited strategy of intervention, leaving existing site geometries as much as possible. It left the road Pacific Parade but removed Camp Drewe Road. Pedestrian connections from town, the Caravan Park, and the regional coastal path were emphasized to encourage walking to the site. Increased visual sightlines between the Surf Life Saving Club the lake were also important. The plan also began to provide an approach to restoration on site, closing some of the gaps in vegetation cover on the south lake shore and revegetating the southwest corner of the site. The Environmental Resource Center was developed as a way to educate users about the restoration occurring on site.

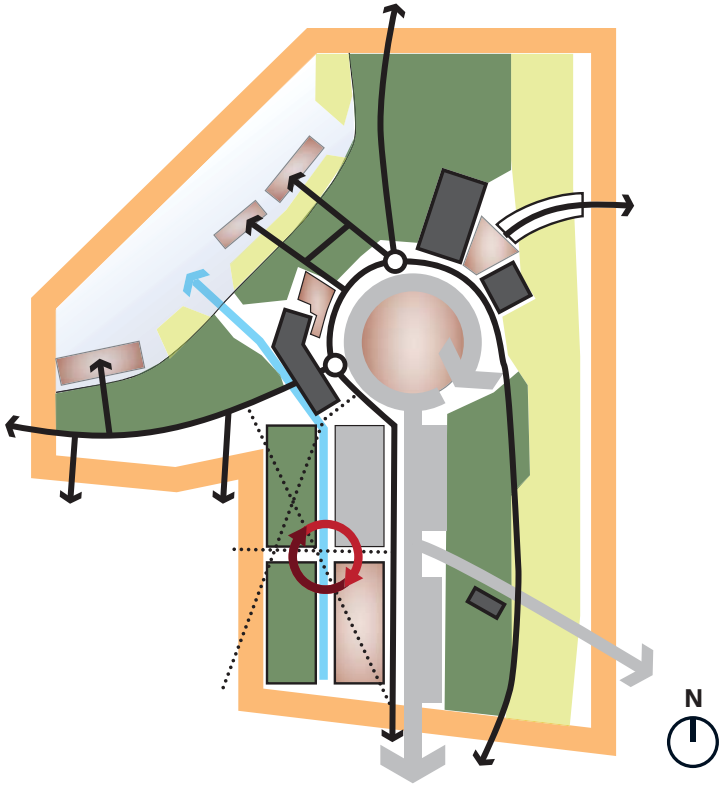


Figure 4.9 Concept Beta

This alternative was developed with the idea of creating a central public space that brought together the Surf Life Saving Club, the Environmental Resource Center, and paths to the beach and lake. In this concept, Pacific Parade was removed to eliminate the road's impact on the lake and to establish the site as a destination point. Furthermore, a series of docks were created to move people out into the water on a permanent surface rather than contribute to erosion by walking on the shore. A final major consideration in this concept was parking. Because parking could easily dominate the site without Pacific Parade, a bus loop to the site would be established. Furthermore, in keeping with the project's vision of integrating nature and development, a rotating set of four plots was created. One would host additional parking, two fast growing trees (to be cut down for on-site lumber needs), and the fourth a community garden.

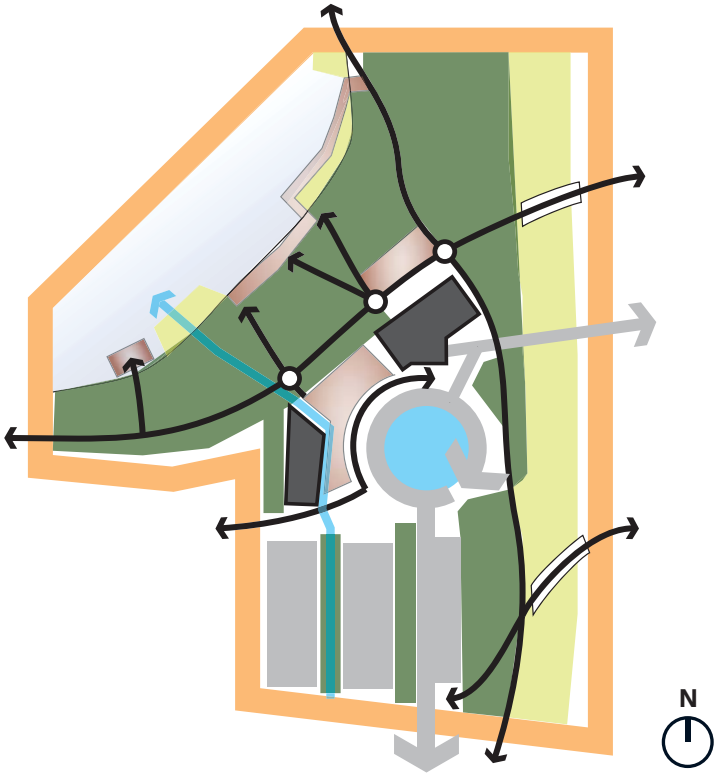


Figure 4.10 Concept Gamma

This alternative continued many of the same ideas as Concept Beta. Because a central public space in the center of traffic circulation could be a safety hazard, the space was pulled out between the Surf Life Saving Club and the Environmental Resource Center. The center of the turnabout then became an artistic stormwater basin. This concept provided the most parking on site with green buffers and stormwater mitigation, but it also lacked the strong pedestrian connections of the former two concepts.

[Focus Site Evolution]

Feedback from a series of critiques helped the final site plan coalesce as a synthesis and improvement upon the three initial concepts. The final site plan is shown on the opposite page (Figure 4.12).

The two roads were eliminated, and the turnabout concept morphed into a parking lane with a drop off lane near the lake. The Surf Life Saving Club were placed closer to the the ocean and the lake to create a stronger connection to both. From the surf club lawn, users can see both the ocean and the lake from the same spot.

The continuity of secondary and tertiary vegetation was increased. The only major gap is the surf club, whose roof shape acts like coastal canopy does, protecting from winds.

Programming was also added on site in order to make the perceptual connection between ecological systems and the site more overt.

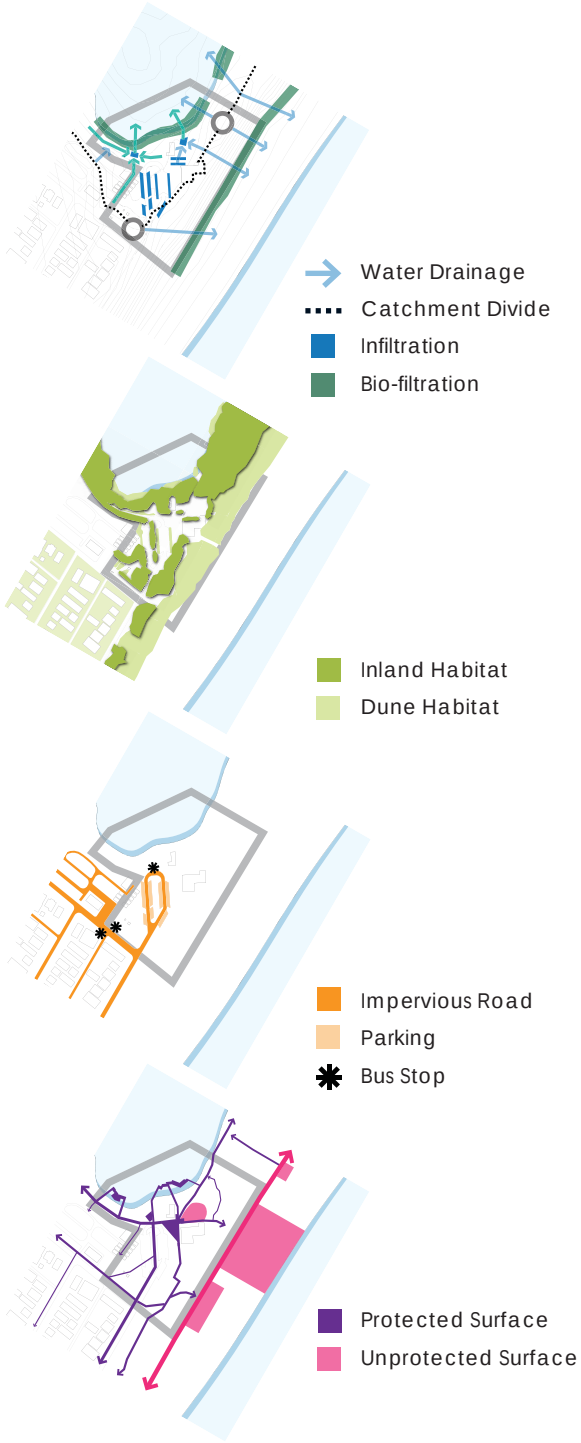


Figure 4.11 Conceptual Site Layers

[Site Layers]

Hydrology

- Runoff typically entering lake is first filtered or captured for infiltration.
- Stormwater drains contribute minimal runoff due to green stormwater BMPs throughout town.

Ecology

- Continuity of dune habitat restored by elevating pedestrian crossings.
- Secondary and tertiary vegetation is restored along coast.
- Former patches connected to each other to increase ecological benefit.
- *Typha* communities replanted along lake edge.

Vehicular Circulation

- Roads along lake are removed.
- Parking capacity is reduced by half but shuttle access and increased paths make it easier to get to site.
- Access to Sport and Recreation Center rerouted around Lake Ainsworth along already existing corridor.

Pedestrian Flow

- Pedestrian paths are upgraded to sidewalks and boardwalks.
- Main corridor from town is now the regional coastal path.
- Sidewalks connecting neighboring residential areas have been added.
- Beach, surf club green, and lake shore are still integral part of site.

Figure 4.12 Lake Ainsworth & Surf Club Site Plan

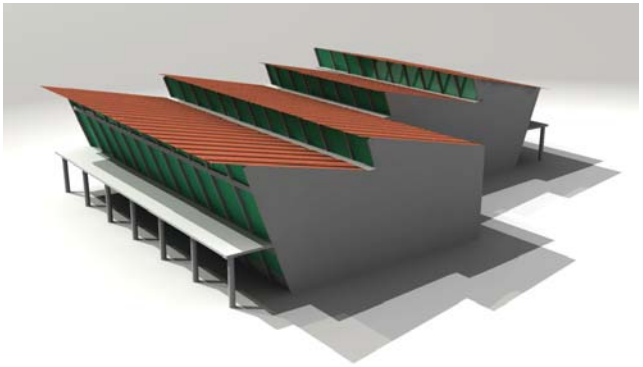


Figure 4.13 Conceptual Surf Club Form

[Surf Life Saving Club]

The Surf Life Saving Club (Figure 4.13) is oriented to maximize views of the ocean and Lennox Point. It also creates a strong relationship with the Environmental Resource Center and the lake. The roof form allows wind from the ocean to flow over the building, and the clerestory provides plenty of natural sunlight during the day.

Figure 4.14 Traffic Reroute to Sport & Recreation Camp

[Vehicular Circulation]

Because of the runoff and erosion issues Pacific Parade north of the site causes, it has been removed. With the market being moved to the town center, the road has relatively small use except for parking. To assuage the high volume of parking that is displaced, sixty-eight new parking spaces, a parking structure at the town center, and increased bike and pedestrian connectivity to the site have been created. Access to the Sport and Recreation Camp, which is primarily used by school groups and sports teams, is rerouted along an existing corridor to the west of Lake Ainsworth (Figure 4.14). Pedestrian traffic can still connect to the camp through the current corridor. Camp Drewe Road has been removed for the same reasons. This removal creates room for the regional bike path to pass along the southern shores of Lake Ainsworth. The removal of the two roads marks the site as the destination point at one end of the main street through Lennox Head. When driving north along Pacific Parade, the Surf Life Saving Club will be visible. On site itself, the approach is oriented to provide views of the lake from the initial parking lane and ocean from the drop-off lane. These basic geometries extend throughout the site, creating a strong emphasis on the two important landscapes of Lennox Head.

Figure 4.15 Regional Coastal Path Approaching Site

[Pedestrian Circulation]

The pedestrian experience is an essential part of the site's success. Existing infrastructure provides only a 2.0 meter wide sidewalk along Pacific Parade or the beach. Neither are great choices. The sidewalk is narrow and provides no mitigation from the sun. While the beach can be pleasant to stroll, high traffic can damage the beach. As a result, the arrival to the site has been greatly improved. The sidewalk along Pacific Parade is widened to 3.0m and street trees are placed along the west side. It provides direct, clear connection to the lake as well as the Surf Life Saving Club and ocean. A secondary pedestrian option is the regional coastal path (Figure 4.15). Winding its way between secondary and tertiary dune vegetation, it provides a scenic view of the ocean while also being more pedestrian friendly than the beach. The coastal path runs through the site, following the south and west side of Lake Ainsworth. Another path enters the site from the north, connecting the Sport and Recreation Camp to the site. It also serves as a nice trail for anyone who desires to hike.

Paths on site provide connection from pedestrian paths, parking, and drop off zone to the Environmental Resource Center, Surf Life Saving Club, lake, and beach. Shade is provided by trees on the north or west side of the path to make the pedestrian experience more comfortable.

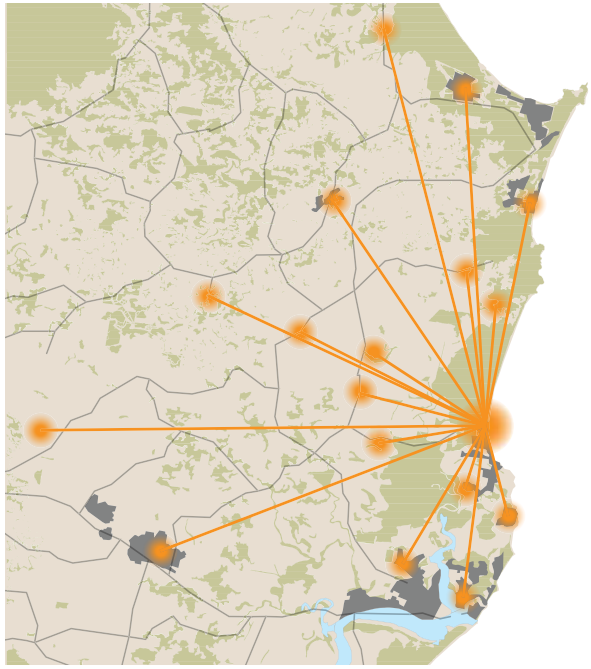


Figure 4.16 Regional Impact

[Environmental Resource Center]

The Environmental Resource Center serves as the educational hub of Lennox Head for the ongoing restoration and integration efforts in the town. It has number of fixed and rotating exhibits which inform people about coastal processes, stormwater management, passive systems, development patterns, and other topics related to integrating natural and built communities. The center will also distribute information on topics that will help people practically landscape with native plants, grow their own food, and install rain gardens. In addition to the exhibit space, the center has a classroom for both school and adult education. Moreover, due to the close proximity of the Caravan Park, visitors to Lennox Head will have exposure to the Environmental Resource Center, which allows it spread its ideas much farther than the town itself (Figure 4.16).

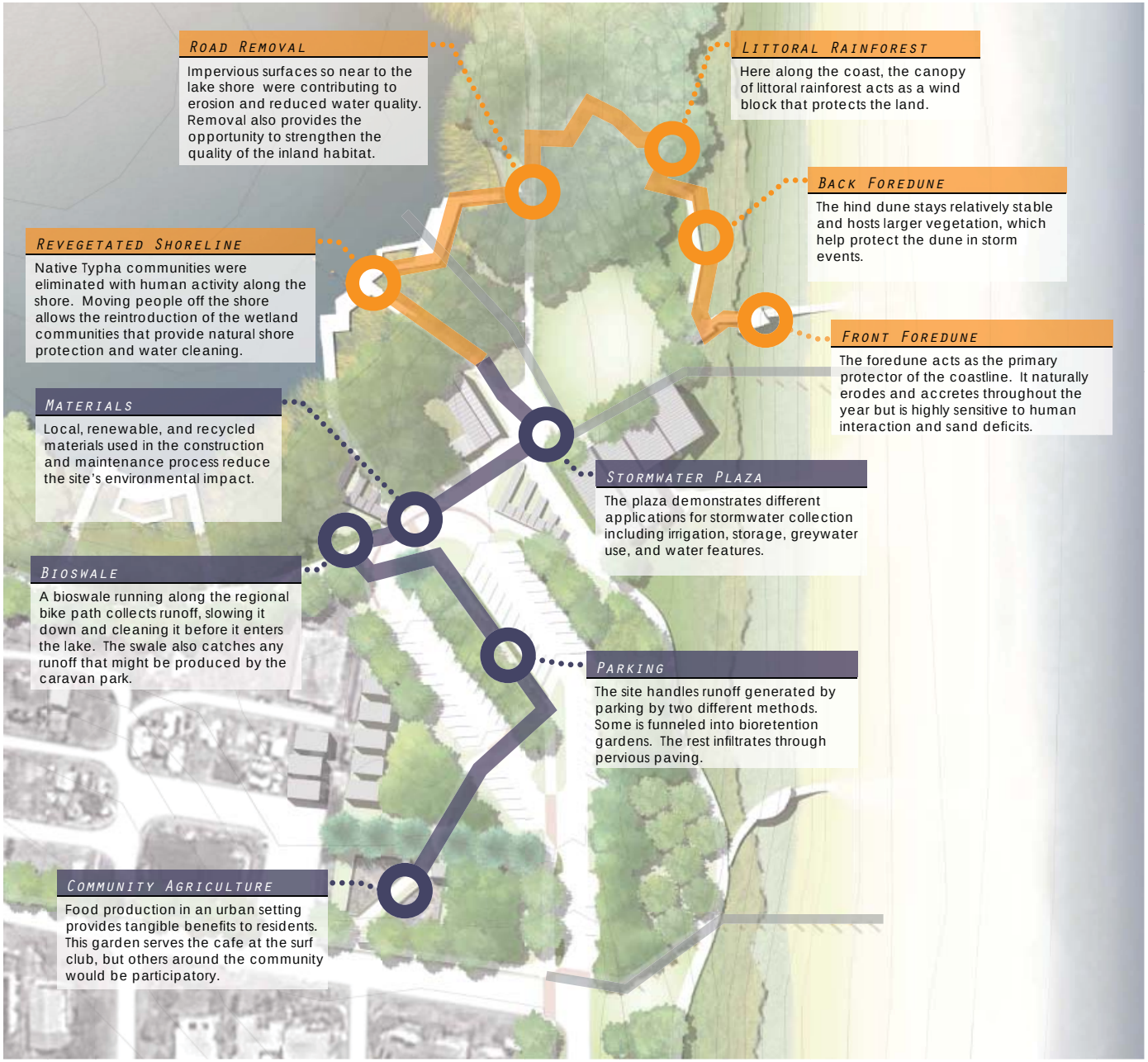


Figure 4.17 Educational Points in Site

[Educational Path]

The landscape of the site itself acts as an extension of the Environmental Resource Center, revealing the features on site that work toward the integration of natural and built communities. A series of educational points create a path through the site starting at the dune crossing and winding its way around to the southwest corner of the site (Figure 4.17). The path has two distinct halves. The first half (orange) focuses on the sensitive nature of the ecological communities in the area. These points discuss both the restoration efforts as well as the intrinsic value of the habitats. The second half (purple) focuses on the physical integration of ecological function and human development. These points discuss development-related actions such as stormwater management, sustainable materials, and food production. As a result, the path acts as a passive educational tool for the community as well as an active opportunity for schools to teach children about their environment in the environment itself.

[Redefined Dune Crossings]

Dune crossings, instead of cutting through the dunes, extend up and over the dunes in a series of boardwalks, much like in Seaside, Florida (see Figures C.10-12). By lifting pedestrian traffic over the dunes, the sensitive habitat is strengthened through continuity. Because beach access for safety vehicles is still required, the existing vehicular path to the beach has been left. Despite one break in the dunes, the new continuity of the dunes is still preferable to the disruption of frequent paths (Figure 4.19).

The dune crossing at the Surf Life Saving Club serves as an educational point about the front foredunes (Figure 4.18). It discusses the restoration process of using dune forming fences and native plantings. It will also talk about the importance of dunes and their vegetation in protecting the shore from receding and how an interruption in the littoral drift pattern due to human development can have major consequences down drift.

The pavilion showcases a set of ecorevelatory poles that extend from the beach all the way to the lake. The poles are framed by a view of Lennox Point, the key identifying feature of the town.

Figure 4.18 Dune Crossing near Surf Club

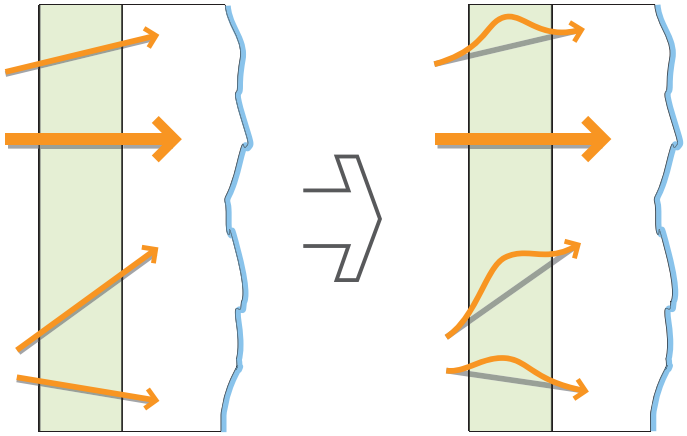


Figure 4.19 Elevated Crossings

Figure 4.20 Boardwalk through Littoral Rainforest

[Restored Littoral Rainforest]

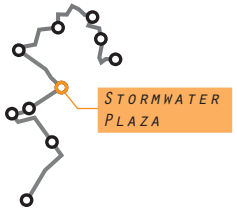
The littoral rainforest is another key point on the educational path (Figure 4.20). While once it extended throughout much of the coast, in Lennox Head only a few small patches are left (see Figures D.1-2). A boardwalk winds its way through the existing forest, avoiding trees. A larger space opens up to provide a place for people to sit or classes to gather on stepped seating.

Figure 4.21 Dock at Lake Ainsworth

[Redefined Lake Shore Interaction]

Interaction with the lake has been moved from the shore out onto a series of docks (Figure 4.21) where people can enjoy the lake in the same way as before: sunbathing, swimming, kayaking, etc. The altered mode of interaction protects the shore from being trampled, causing erosion, and allows native wetland communities to be restored. The docks interweave with the *Typha* plantings, giving people opportunities for tactile interaction with their environment.

Figure 4.22 Plan of Stormwater Plaza



[Stormwater Plaza]

The plaza between the Surf Life Saving Club and Environmental Resource Center provides a place for people to enjoy the outdoors (Figure 4.22). As relief from the hot sun, ample shade is provided through trees and canopy structures. The plaza showcases ways to handle stormwater on a developed site (Figure 4.23). All rain that falls in the plaza is directed into a series of linear infiltration basins with wetland plantings (Figure 4.24). If water fills these basins during the heavy rains the region experiences, they overflow into an exposed runnel that moves the water into another set of infiltration basins at the opposite end of the plaza. If these overflow, water is released through a vegetated swale into the lake. Runoff from the two roofs are either collected in rain barrels or poured playfully into the infiltration basins. Runoff from the lawn is collected in a trench drain and released into the secondary infiltration basins.

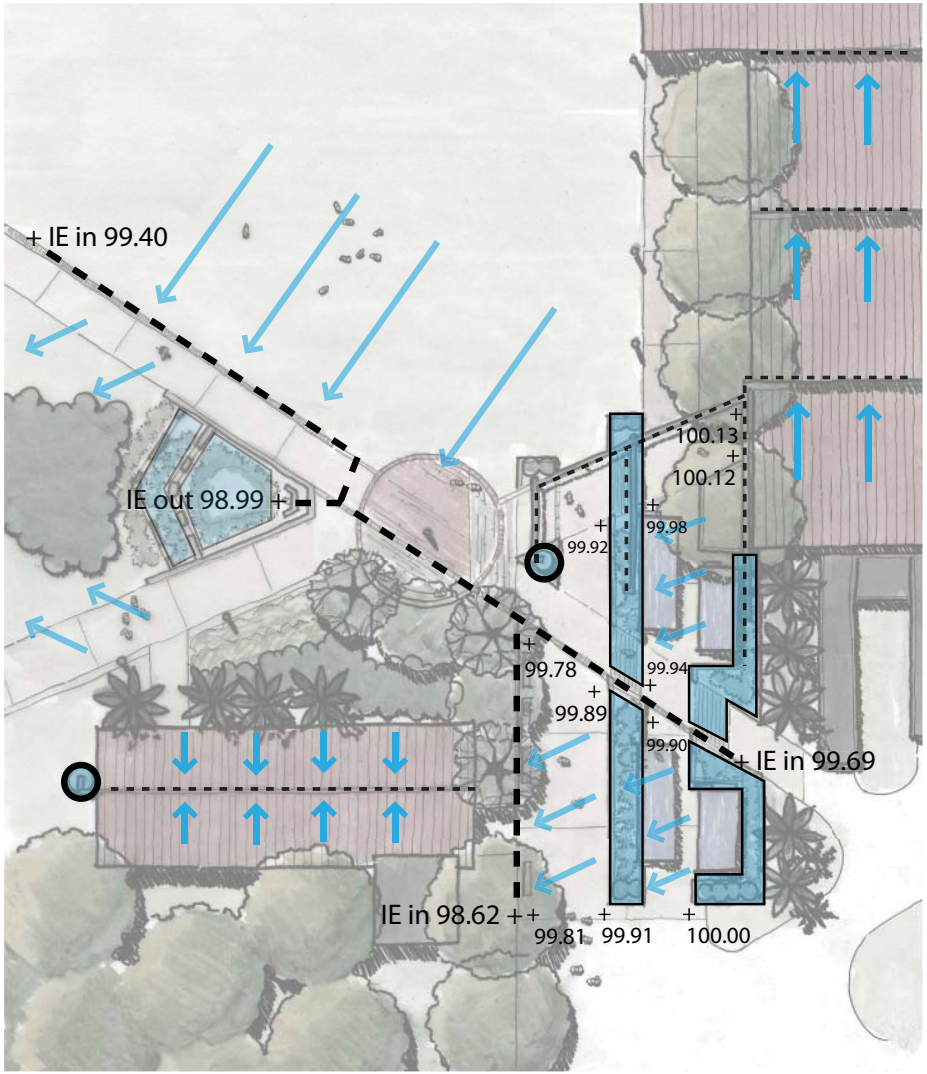


Figure 4.23 Drainage & Key Sample Elevations

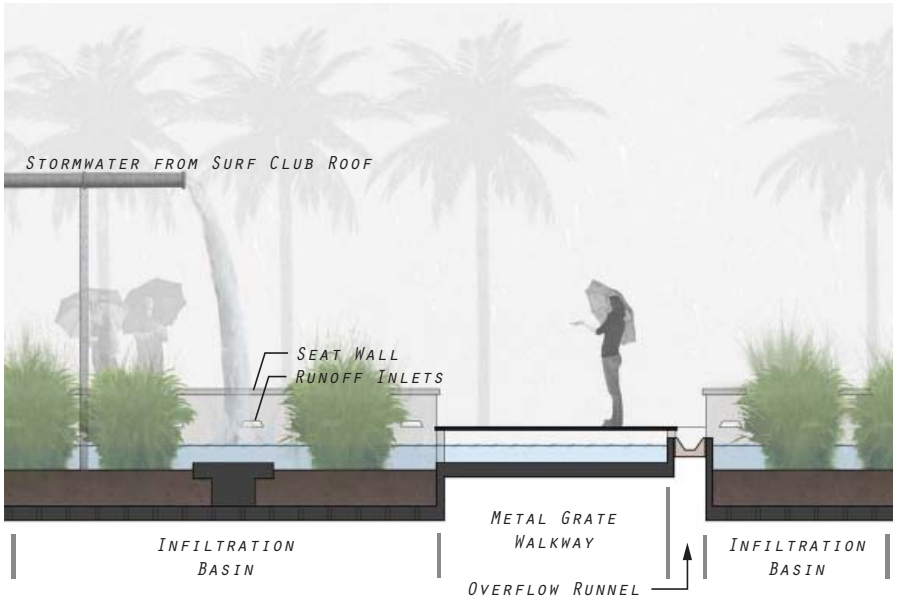
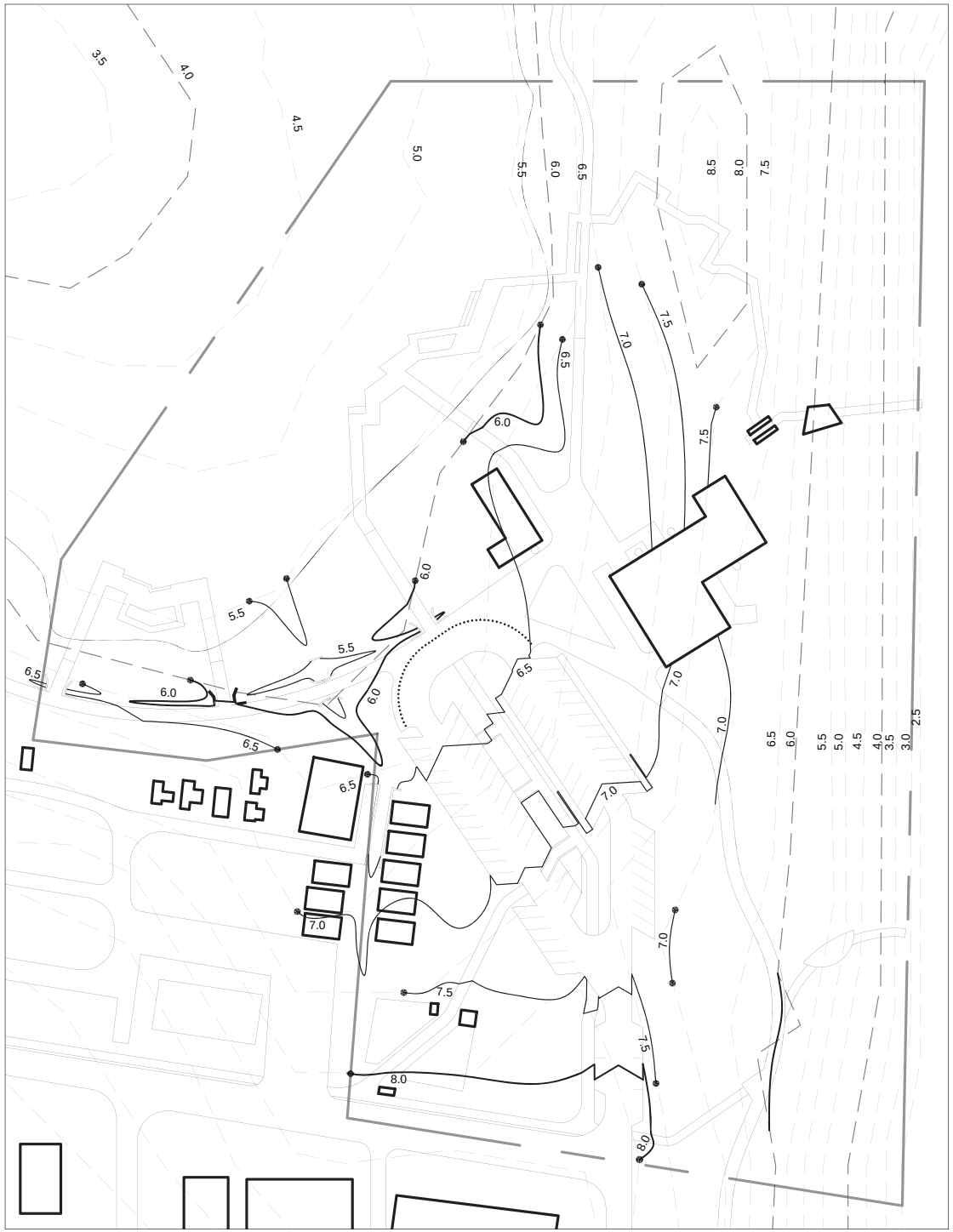


Figure 4.24 Water Basin Detail

Figure 4.25 Swale near South Shore of Lake

[Bioswale]

Along the north edge of the regional coastal path a swale captures runoff from the path and the Caravan Park (Figure 4.25). It filters the water before it enters the lake, improving Lake Ainsworth's water quality. A small boardwalk platform extends at over the swale near the check dam with a sign explaining how the swale cleans the water.



[Site Grading]

Site elements are placed to retain almost the same catchment boundary as currently exists. Minimal topography alteration is necessary not only to preserve drainage patterns but also to protect existing vegetation (Figure 4.26).

The Surf Life Saving Club lawn now drains to the lake, but is first filtered with vegetation. In addition, the Caravan Park and west part of the coastal path run send runoff to a swale, which filters water before entering the lake. Other parts of the site, such as parking and the plaza let water infiltrate instead of sending it away.

Figure 4.26 Site Grading Plan

[Conclusion]

This project creates a framework for ecological sustainability through the lens of integrating healthy natural systems and human infrastructure in Lennox Head. It employs both ecocentric and anthropocentric viewpoints to create a healthy relationship between society and nature. As a result, the design does not sacrifice the needs of the community for the sake of being sustainable. Integration then is accomplished through two main areas, physical networks and social perceptions.

Physical integration revolves around creating new networks that interweave elements of natural environments and development. The project plans for the expected town growth while alleviating Lennox Head's ecological issues. The projected increased population is handled through denser development and improved transportation networks to reduce virgin land consumed by the village. Healthy, adaptive environments are at the same time created by restoring the dunes, littoral rainforest, and lake; increasing the ecological value of the town through habitat corridors, green infrastructure, and native landscaping; and returning to a natural pattern of stormwater through filtration, infiltration, and retention. These changes will occur both as retrofits to the existing town infrastructure and as integral features of growth-spurred development.

The physical aspect, however, cannot achieve integration on its own. People of the town must understand and embrace the changes in development patterns in order create a true integration between natural and built environments. It is therefore important to cultivate new cultural notions of what normal development is. Otherwise, the town will remain ecological sustainable only in the short term. For this reason, social perceptions are also addressed in this project. The design stimulates shifts in perception through several methods. It provides places for people to interact with nature by creating opportunities for people to move through the restored habitats and by involving the public in community agriculture. Direct landscape benefits are also emphasized through shade, increased aesthetics, and recreational opportunities. Educational features reveal natural processes and sustainable development through ecorevelatory design, signage, and an educational center.

The Surf Life Saving Club along the south shore of Lake Ainsworth serves as a model for the new physical and social patterns of development in Lennox Head. It creates healthy ecosystems by rebuilding the eroded dunes, restoring secondary and tertiary dune vegetation, and restoring the degraded shores of the lake. These healthy ecosystems have several significant effects. They help protect the natural assets of Lennox Head, particularly the lake and the beach. They also increase the town's resiliency by protecting against heavy storms, flooding, and drought. Furthermore, the elimination of Pacific Parade and Camp Drewe Road along Lake Ainsworth places an emphasis on the pedestrian and public transportation network that connects to the site. The built portion of the site also encourages ecological health by filtering stormwater through bioswales, capturing it in bioretention areas, or storing it for greywater use.

The site is the center of Lennox Head for shifting public perception, which is equally as important as physical integration. Education is a key part of the site programming. The Environmental Resource Center serves as a classroom and exhibit space to educate residents and visitors about the principles of ecological integration. The landscape

itself acts as an extension of the center, revealing both the sensitive nature of the ecological communities in the area and the sustainable site elements.

Combining a deep value for human quality of life with an overarching concern for the ecological health, this project establishes a dynamic design for coastal village of Lennox Head. The implications for this approach to sustainable development extend beyond the town itself. It is highly relevant to the small coastal villages found throughout Australia. It is furthermore more broadly relevant to development patterns in general. By addressing physical networks and social perceptions that integrate natural and built environments, communities can move toward a sustainable future that meets the needs of both the environment and human society.

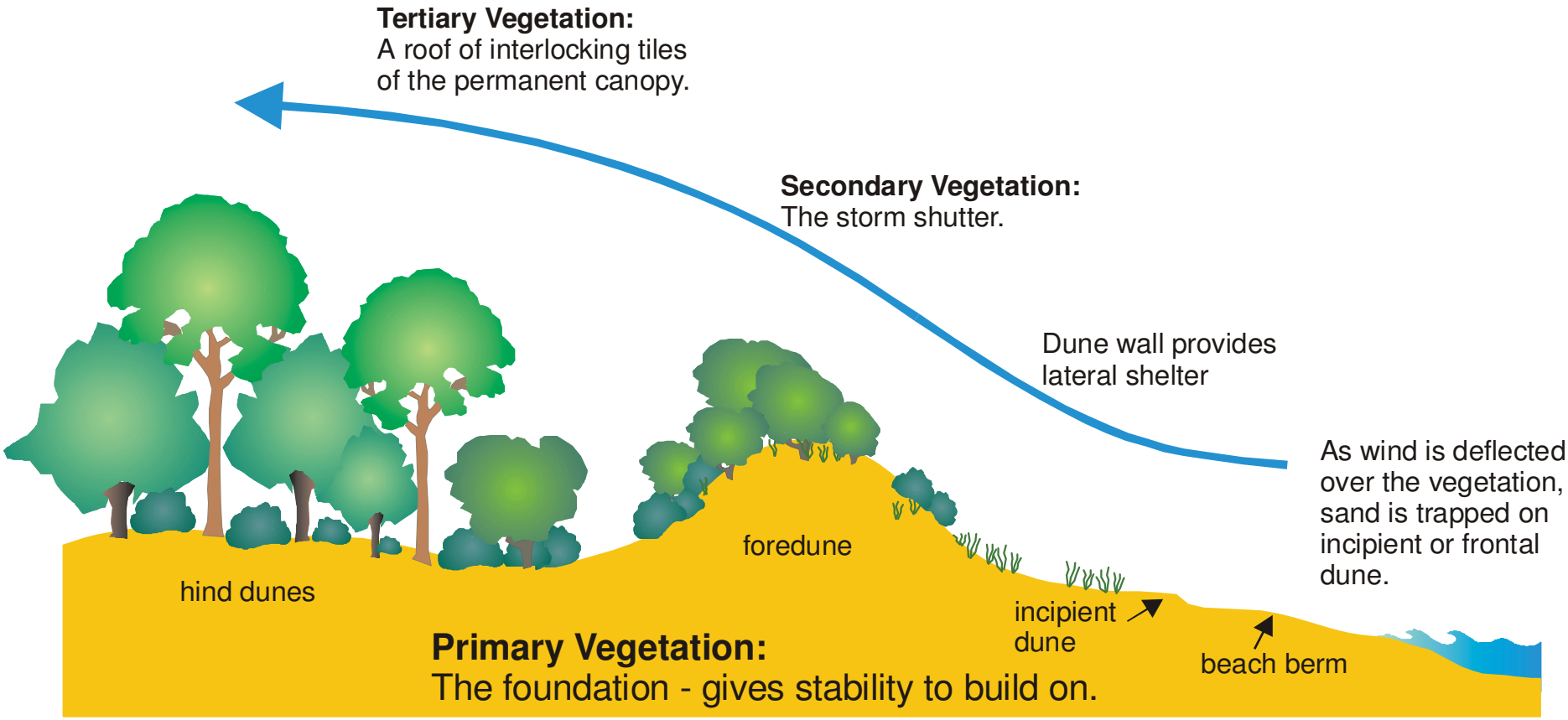


Figure A.1 Dune Vegetation and its Function

Source: Coastal Dune Management

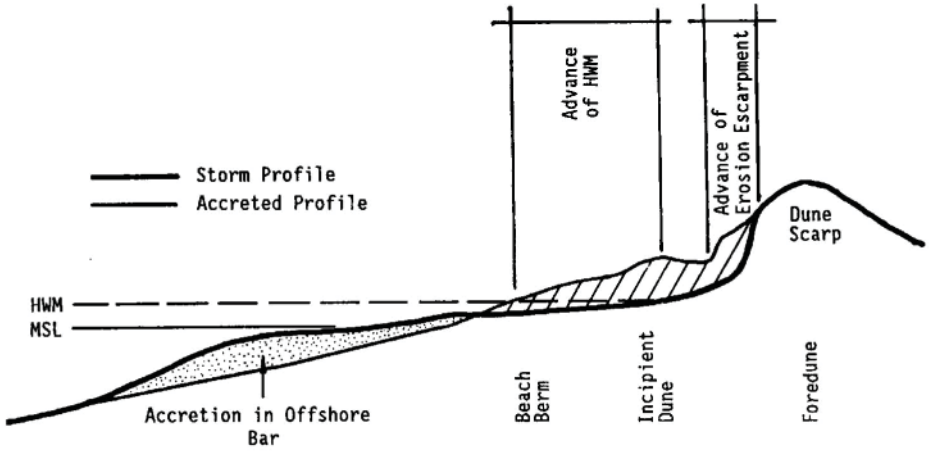


Figure A.2 Storm Erosion Profile
Source: Coastline Hazard Definition Study

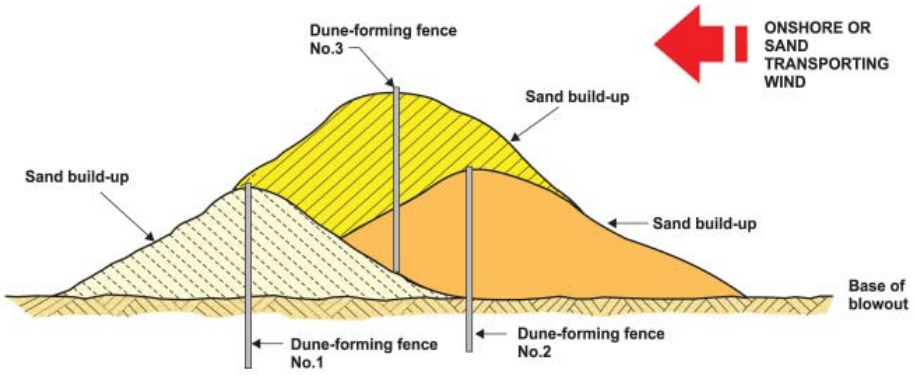


Figure A.3 Dune Forming Fence
Source: Coastal Dune Management

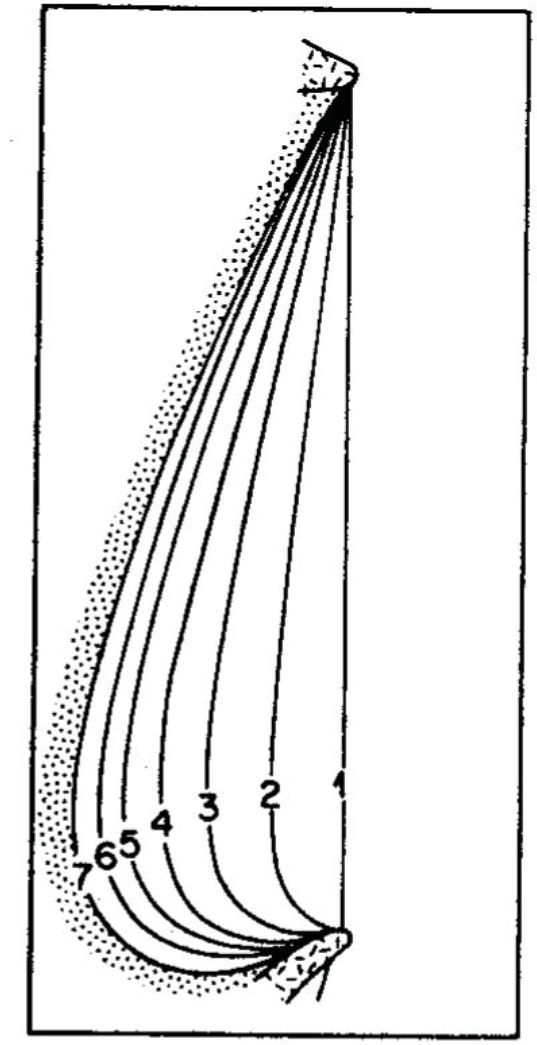
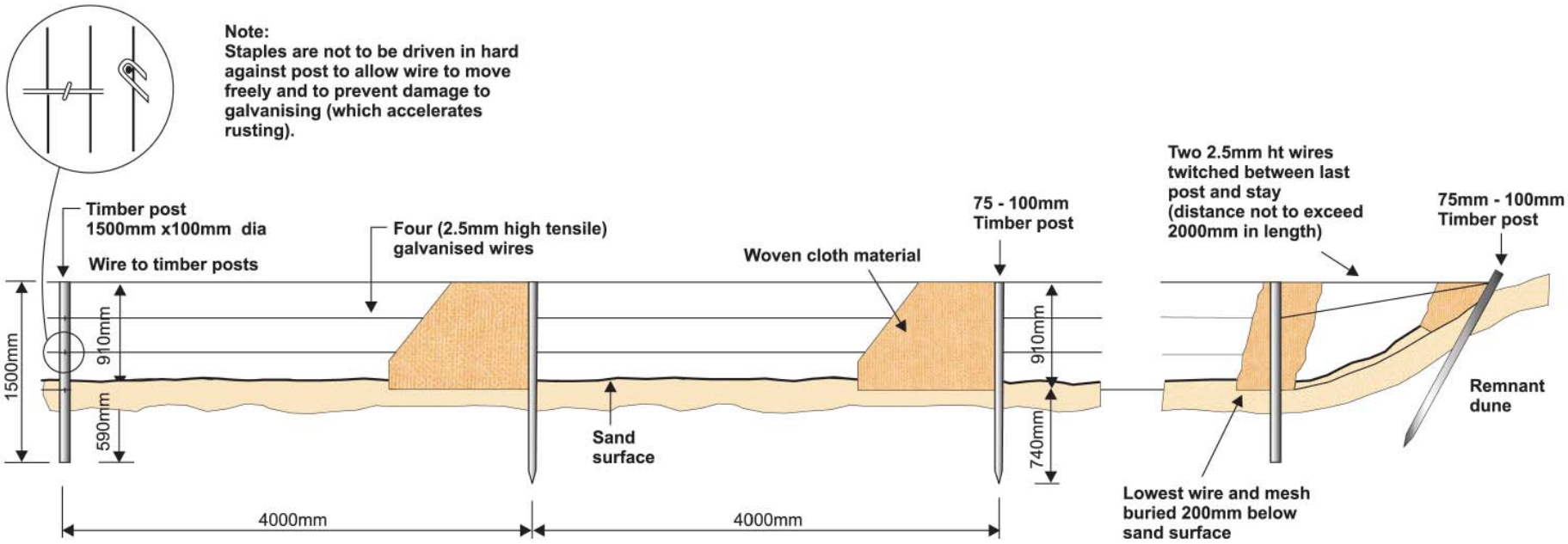


Figure A.4 Beach Erosion Sequence
Source: Coastline Hazard Definition Study



Notes:

1. Wire and mesh to go on seaward or prevailing weather side of fence.
2. Mesh to be fastened to all wires using ring fasteners at 100-150mm intervals on top wire and 300mm intervals on other wires.
3. Use one wooden post every 4000mm.
4. Metal posts should be avoided.

Figure A.5 Typcial Dune Forming Fence

Source: Coastal Dune Management

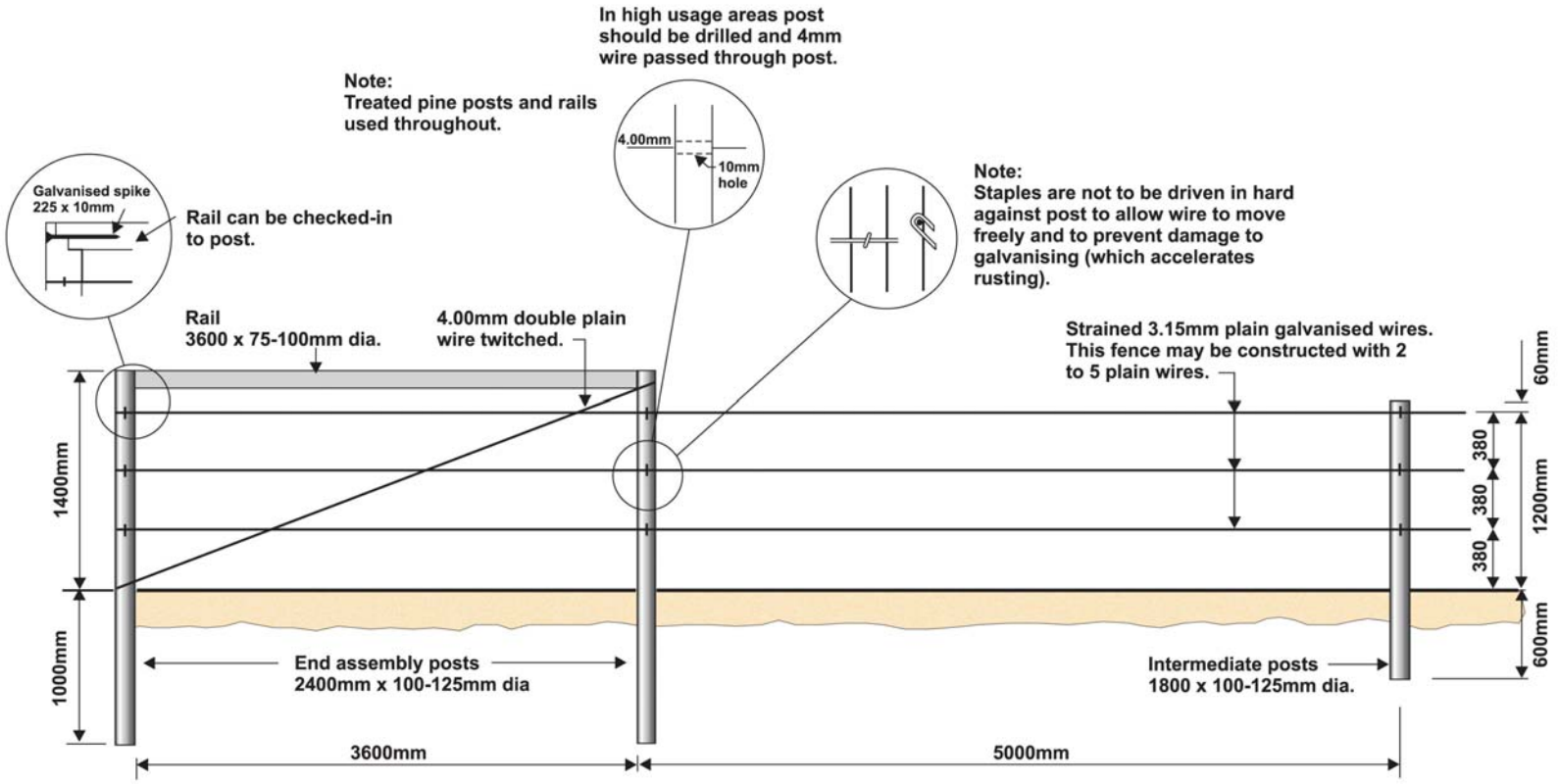


Figure A.6 Typcial Protective Fence

Source: Coastal Dune Management

[Appendix B: Native Plants]

Family	Scientific name	Common name
Grasses & Groundcovers		
Aizoaceae	*Tetragonia tetragonoides*	Warrigal Spinach
Aizoaceae	*Carpobrotus glaucescens*	Native Pigface
Asteraceae	*Melanthera biflora*	Melanthera
Commelinaceae	*Commelina cyanea*	Blue Commelina
Convulvulaceae	*Ipomoea pes-caprae*	Goats Foot
Cyperaceae	*Isolepis nodosus*	Knobby Clubrush
Fabaceae	*Carnavalia rosea*	Beach Bean
Lilliaceae	*Crinum pedunculatum*	Swamp Lily
Lomandraceae	*Lomandra longifolia*	Mat Rush
Phormiaceae	*Dianella crinoides*	Flax Lily
Poaceae	*Spinifex sericeus*	Spinifex
Poaceae	*Imperata cylindrica*	Bladey Grass
Shrubs & Trees		
Casuarinaceae	*Casuarina equisetifolia*	Horsetail She-oak
Casuarinaceae	*Casuarina glauca*	Swamp She-oak
Cupressaceae	*Callitris columellaris*	Coastal Cypress
Dodonaea	*Dodonaea triquetra*	Hop Bush
Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash
Epacridaceae	*Monotoca elliptica*	Tree Broom-heath
Euphorbiaceae	*Mallotus discolour*	Yellow Kamala
Euphorbiaceae	*Glochidion sumatranum*	Cheese Tree
Euphorbiaceae	*Macaranga tanarius*	Macaranga
Fabaceae	*Acacia sophorae*	Coast Wattle
Lauraceae	*Cryptocarya triplinervis*	Three-veined Laurel
Lauraceae	*Cryptocarya foetida#*	Stinking Cryptocarya
Malvaceae	*Hibiscus tiliaceus*	Cottonwood
Moraceae	*Ficus watkinsiana*	Strangler Fig
Moraceae	*Ficus obliqua*	Small-leaved Fig
Myrsinaceae	*Rapanea variabilis*	Variable Muttonwood
Myrtaceae	*Melaleuca quinquenerva*	Broad-leaved Paperbark
Myrtaceae	*Corymbia intermedia*	Pink Blood-wood
Myrtaceae	*Austromyrtus dulcis*	Midgen Berry
Myrtaceae	*Acmena smithii*	Lily Pilly
Myrtaceae	*Syzygium oleosum*	Blue Lily Pilly
Myrtaceae	*Leptospermum polygalifolium*	Lemon Scented Tea-tree
Pandanaceae	*Pandanus tectorius*	Pandanus
Pittosporaceae	*Pittosporum revolutum*	Sweet Pittosporum
Pittosporaceae	*Pittosporum undulatum*	Hairy Pittosporum
Proteaceae	*Banksia integrifolia*	Coast Banksia
Proteaceae	*Banksia aemula*	Wallum Banksia
Rutaceae	*Acronychia imperforata*	Beach Acronychia
Sapindaceae	*Cupaniopsis anacardoides*	Tuckeroo
Sapindaceae	*Alectryon coriaceus*	Beach Birds-eye
Sapindaceae	*Guioa semiglauca*	Guioa
Sterculiaceae	*Commersonia bartramia*	Brown Kurrajong
Thymeleaceae	*Wikstroemia indica*	Wikstroemia
Vines		
Bignoniaceae	*Pandorea pandorana*	Wonga Vine
Dilleniaceae	*Hibbertia scandens*	Guinea Flower
Menispermaceae	*Stephania japonica*	Snake Vine
Moraceae	*Maclura cochinchinensis*	Cockspur
Philesiaceae	*Geitonoplesium cymosum*	Scrambling Lily
Smilaceae	*Smilax australis*	Austral Sarsaparilla
Vitaceae	*Cissus antarctica*	Water Vine
Vitaceae	*Cayratia clematidea*	Slender Grape

listed as vulnerable, Schedule 2, on the NSW *Threatened Species Conservation Act* 1995

Figure B.1 Species Native to Seven Mile Beach

Source: Seven Mile Beach Vegetation Management Plan

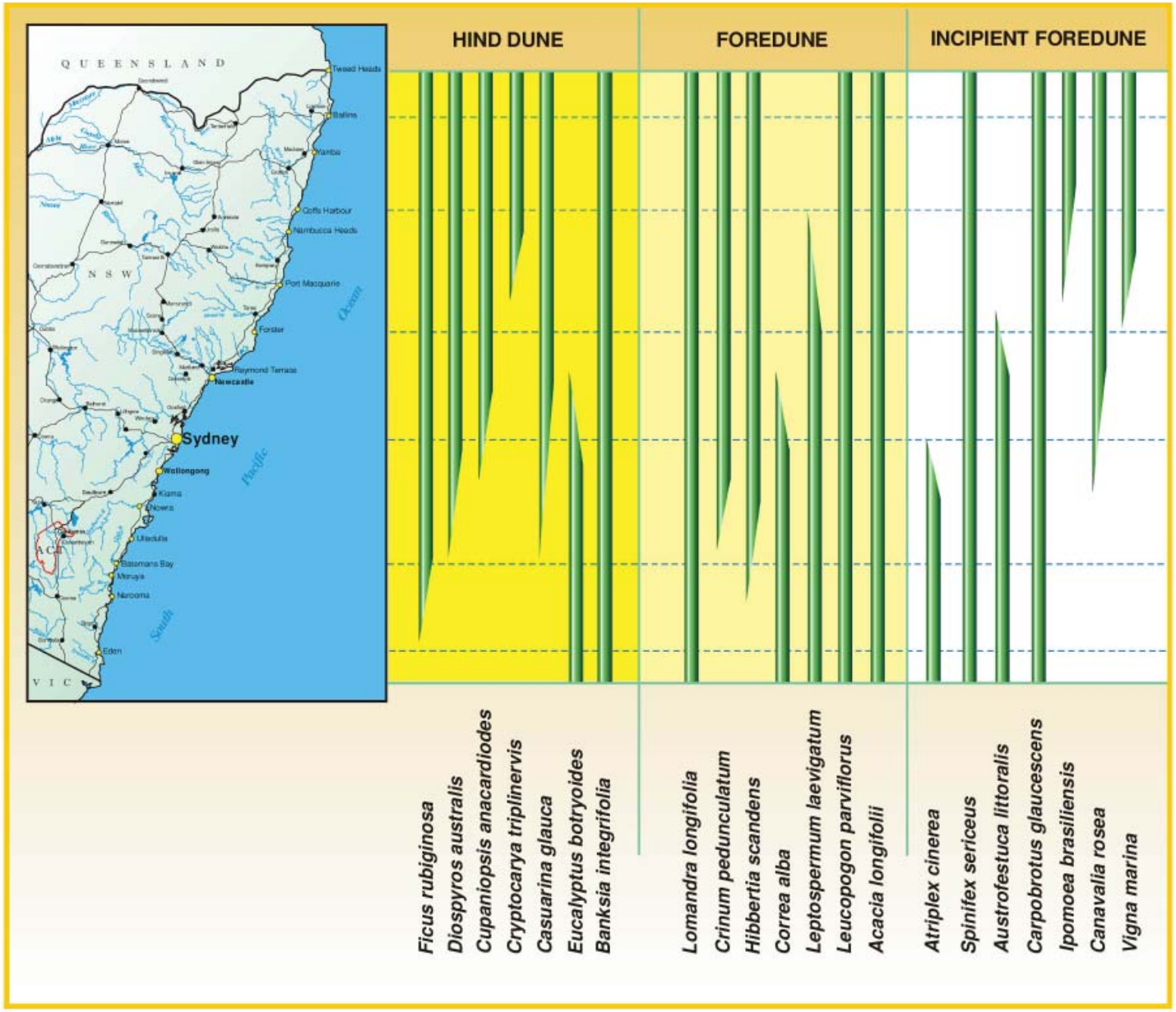


Figure B.2 Common Dune Vegetation Species

Source: Coastal Dune Management

Currumbin Ecovillage

Figure C.1 Stormwater Retention

Figure C.2 Low Density Residential

Figure C.3 Low Density Residential

The sustainability-based neighborhood about 70 km north of Lennox Head was able to retain 99% of the native trees that naturally existed on-site, despite development covering about 20% of the land (Figures C.1-3). Even so, the neighborhood boasts the same yield as standard development. While half of the undeveloped land has been reserved explicitly for habitat (Figure C.4), the ecovillage uses the rest for public space, community gardens, other food production, and even sustainable timber harvesting (The Ecovillage at Currumbin).

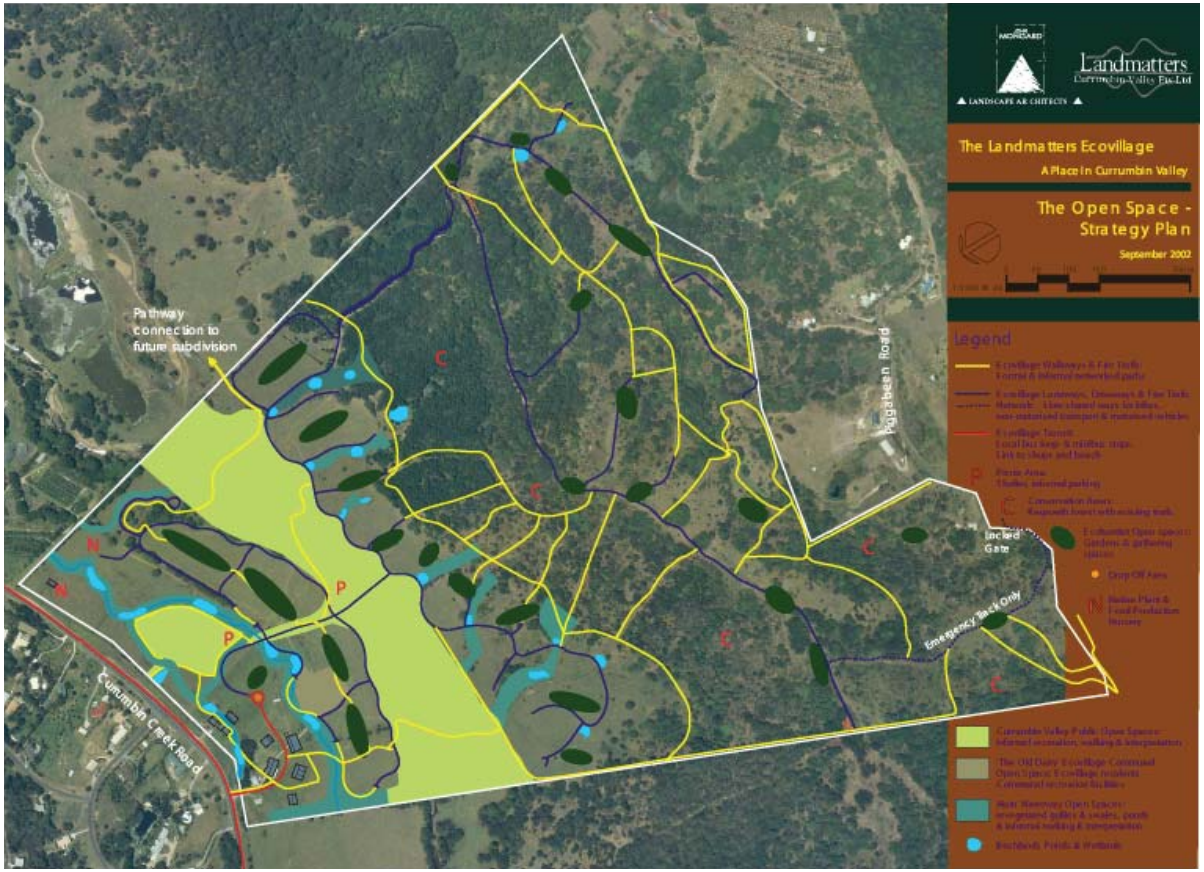


Figure C.4 Ecovillage Master Plan

Image credit: The Ecovillage at Currumbin

Evergreen Brick Works

This industrial reclamation project along the riverfront in Toronto creates means for social interaction and activities by transforming into a community development that aims to bridge the distance between urbanism and ecology. Its master plan includes an environmental learning center, children's gardens, an organic restaurant, farmer's market, and event facilities (Figures C.5-7). These elements are all placed with the purpose of turning public attention to environmental issues. In many ways, the project was more about creating a connection between nature and culture than the physical restoration of the site (Lister 543).

Figure C.5 Main Community Space
Image credit: Du Toit Allsopp Hiller Architects

Figure C.6 Converted Factory, Summer
Image credit: Du Toit Allsopp Hiller Architects

Figure C.7 Converted Factory, Winter
Image credit: Du Toit Allsopp Hiller Architects

South Carolina

After Hurricane Hugo devastated South Carolina's coast in 1989, the Soil Conservation Service installed dune forming fences for a period of two months to rebuild the foredune system lost in the storm. Protection from human traffic was essential during this time period, so public awareness was used to keep visitors on provided walkways. The end result was a new dune system that was four feet tall in most places (Cribb).

Figure C.8 Initial Eroded Landform

Image credit: Clements

Magenta Beach

A dune restoration was undertaken at Magenta Beach (Figure C.8) on the New South Wales coast in February 2006. By November 2008, most observed areas had significantly increased surface coverage of plants. The project tested three different methods of primary revegetation: planting collected Pigface stolons, nursery Pigface stolons, and Spinifex grass seed. Grass seed was determined the most effective at creating coverage, although a combined approach using stolons was recommended since the stolons would cover an area quickly, only to die back, leaving available nutrients (Figure C.9). The project also concluded that primary vegetation needs to be planted before secondary, that microclimates created by coastal tea trees are important, and that bird roosts encourage natural succession (Clements 725, 727-729, 736, 739).

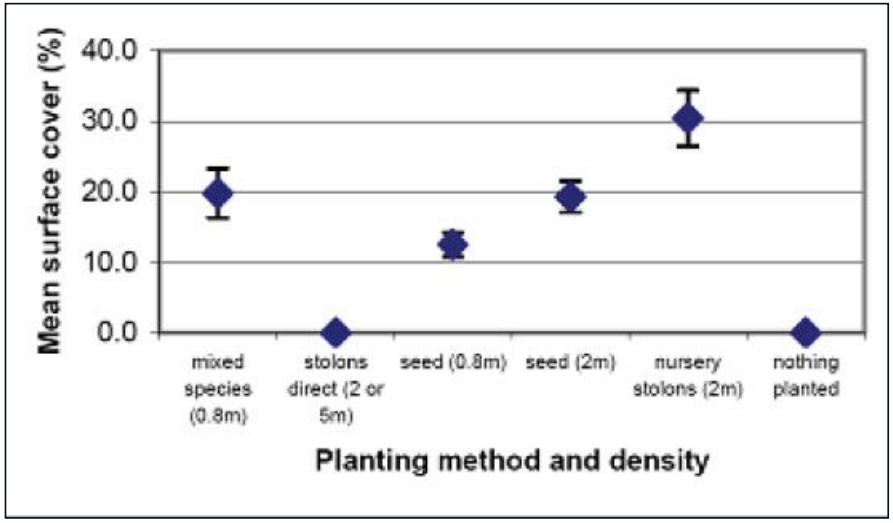


Figure C.9 Vegetation Cover after One Year

Source: Clements

Seaside Pavilions

The town of Seaside, Florida, has created a series of pavilions (Figures C.10-12) that serve as crossings to the beach that go up and over the dunes. They were originally planned by one of the town's founders, Robert Davis, as a way to prevent Seaside from becoming the condo-lined beachfront typical to many coastal towns. The pavilions have become an iconic part of the town and are used for anything from lunches to weddings ("Seaside Pavilions").

Figure C.10 Natchez Pavilion by Jersey Devils
Image credit: Jersey Devils

Figure C.11 East Ruskin Pavilion by S. Cohen & A. Nereim
Image credit: SoWal.com, the South Walton BeachZine

Figure C.12 West Ruskin Pavilion by M. Donough
Image credit: seasidefl.com, official Seaside website

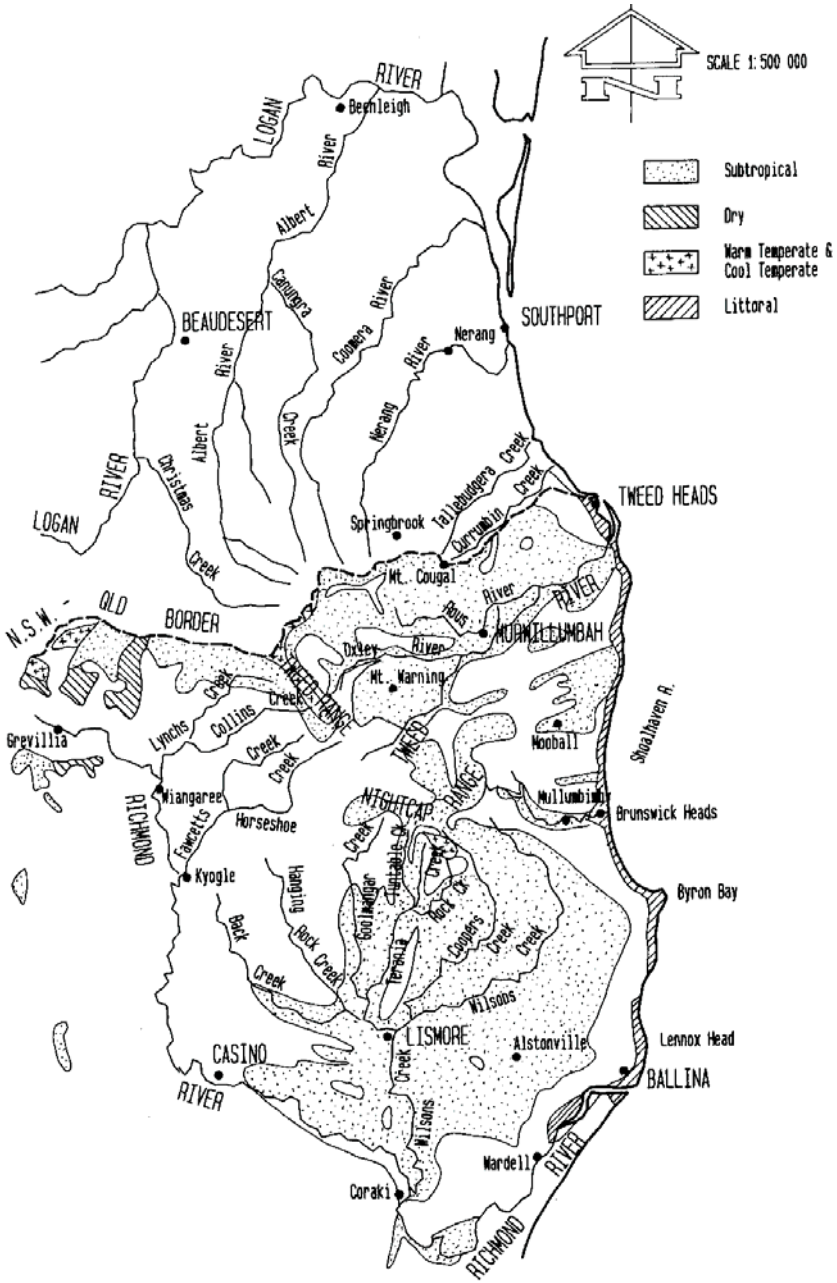


Figure D.1 Pre-Settlement Vegetation

Source: Seven Mile Beach Vegetation Management Plan

Littoral rainforest is believed to have existed all along the coast of Seven Mile Beach presettlement.

Areas in orange below are the three patches that remain of littoral rainforest in Lennox Head.

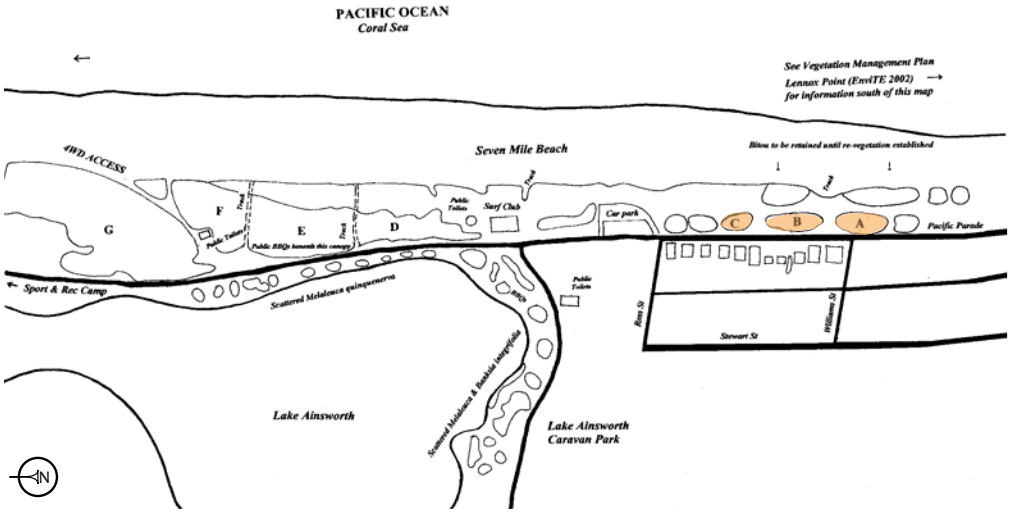


Figure D.2 Existing Coastal Vegetation Near Lake Ainsworth

Source: Seven Mile Beach Vegetation Management Plan

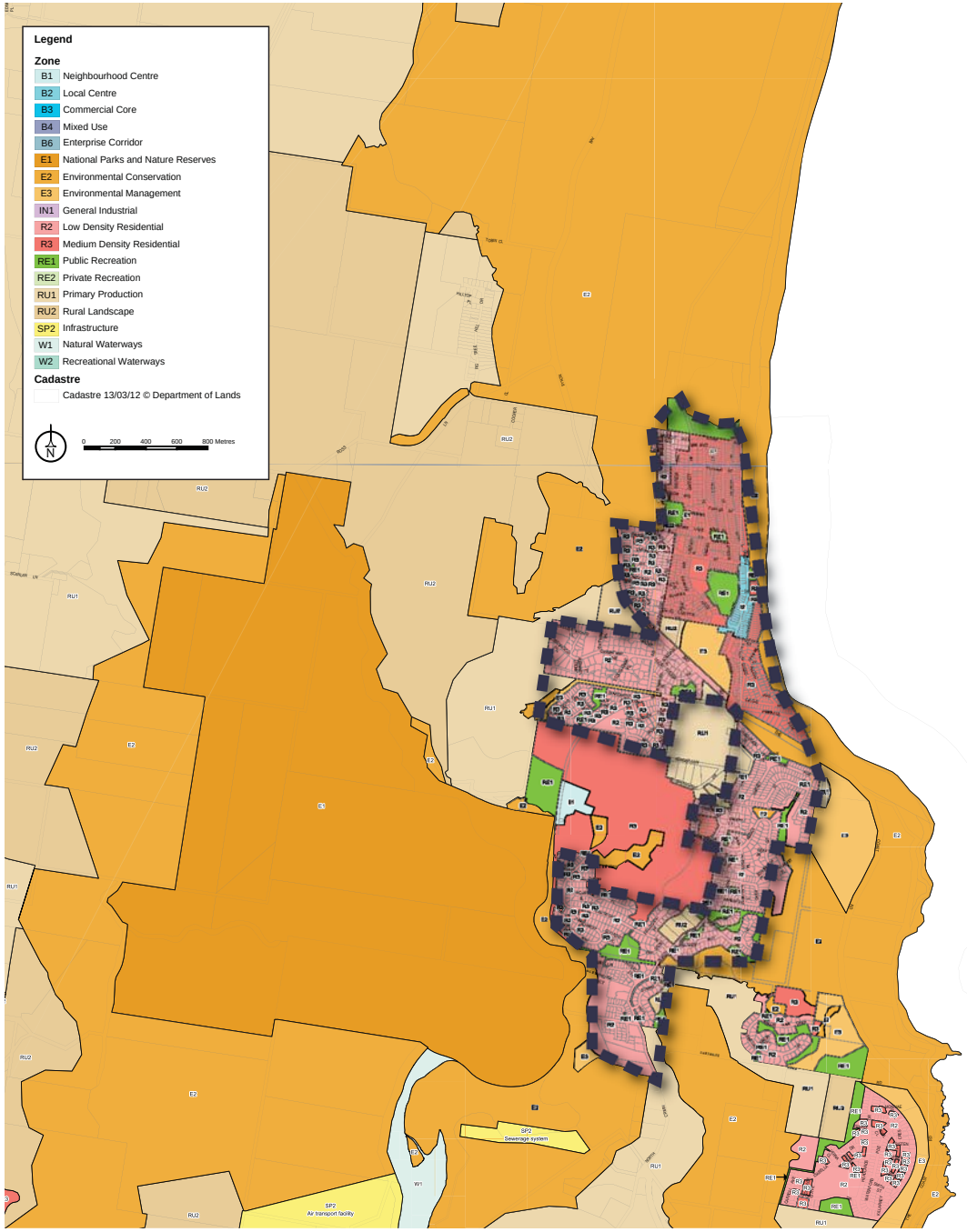


Figure D.3 Land Zoning Map

Source: Ballina Local Environment Plan 2011

LEGEND

- Existing or Imminent Dual Reticulation
- Proposed Dual Reticulation
- Existing Open Space Irrigation
- Proposed Open Space Irrigation
- Proposed Irrigation of Regenerated Vegetation
- Potential Constructed Wetland or Irrigation of Regenerated Vegetation
- Existing Wastewater Treatment Plant (WWTP)
- Potential Recycled Water Treatment Plant (RWTP) Location
- Potential Recycled Water Reservoir (RWR) Location
- Existing Recycled Water Pipeline
- Proposed Recycled Water Pipeline

1. Proposed Recycled Water Reservoir near Ross Lane / Pacific Highway Junction
2. Proposed Recycled Water Reservoir at Cumbalum / Ballina Heights
3. Existing Ballina Wastewater Treatment Plant (WWTP)
4. Potential Recycled Water Treatment Plant adjacent to Ballina WWTP
5. Potential Recycled Water Treatment Plant at Southern Cross Industrial Estate
6. Existing Lennox Head Wastewater Treatment Plant (WWTP)
7. Potential Recycled Water Treatment Plant within the Lennox Head WWTP site
8. Alternate Locations for Proposed Recycled Water Reservoir at Lennox Head

Figure D.4 Shire Recycled Water Master Plan

Source: Ballina-Lennox Head Recycled Water Master Plan

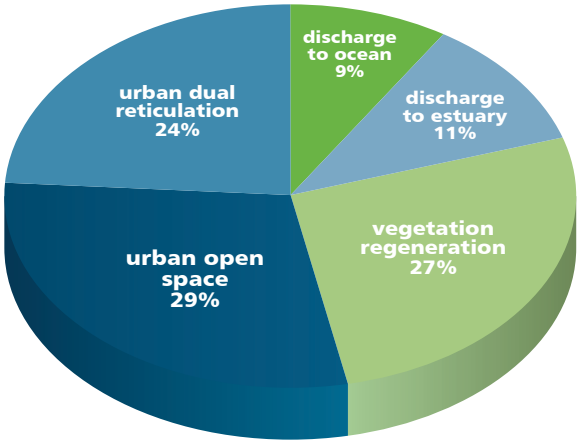


Figure D.5 Proposed Water Balance by 2026

Source:Ballina-Lennox Head Recycled Water Master Plan

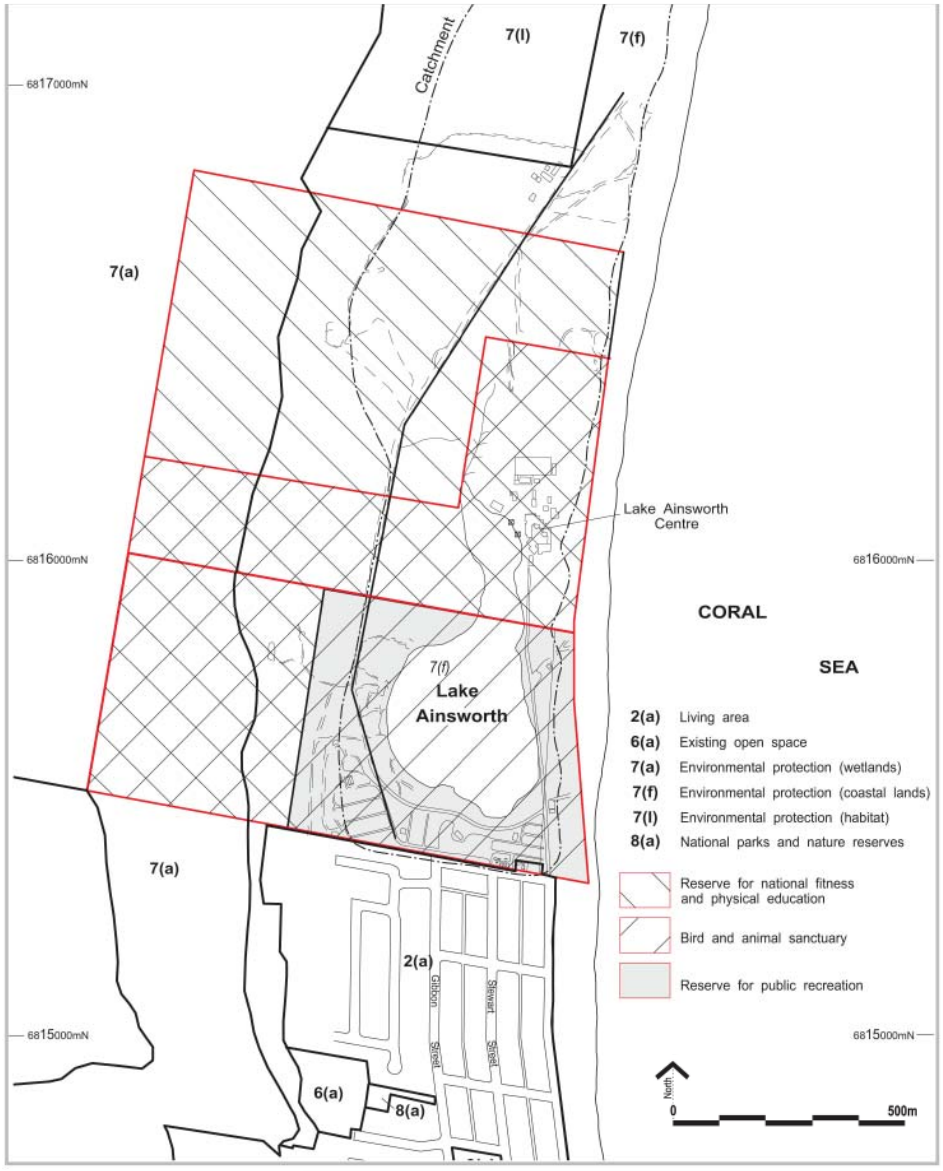


Figure D.6 Shire Council Zoning for Lake Ainsworth

Source: Lake Ainsworth Management Plan

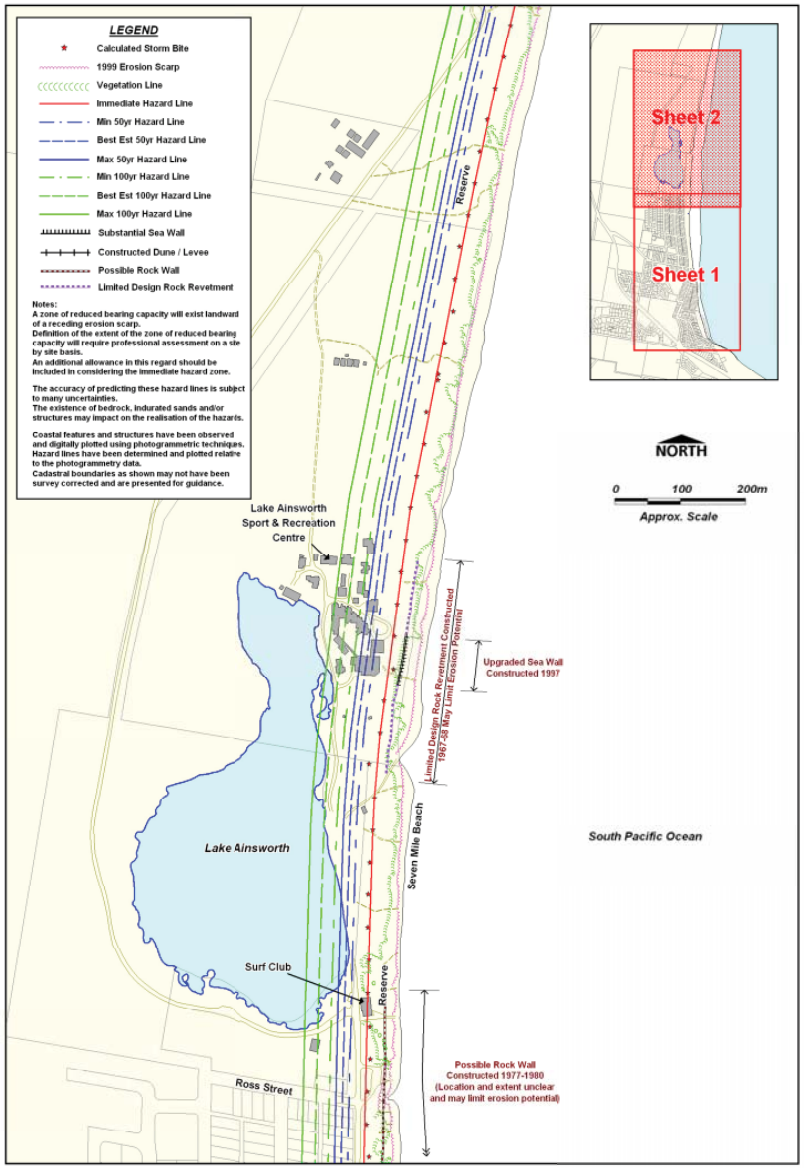


Figure D.7 Erosion Hazard Zones

Source: Ballina Coastline Interim Measures and Action Plan

Figure D.8 Proposed Coastal Cycleway Route: Lennox Head Village

Source: Ballina Shire Council

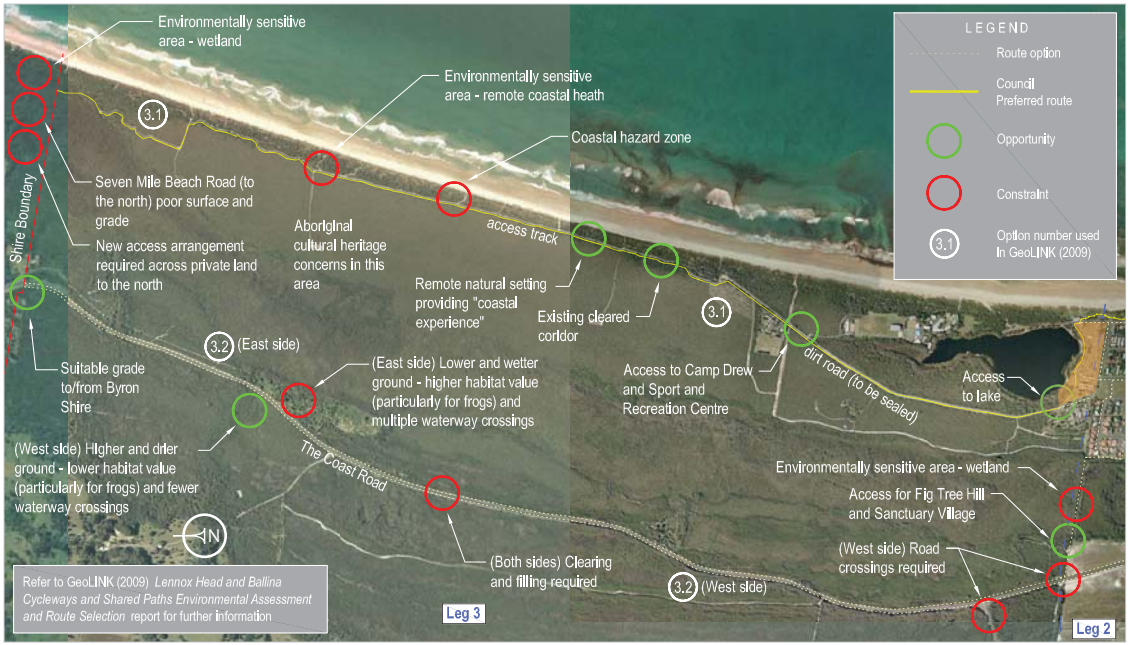


Figure D.9 Proposed Coastal Cycleway Route: North of Lennox Head

Source: Ballina Shire Council

[Appendix E: Site Images]

Figure E.1 Lennox Point

Lennox Point (Figures E.1-2) is one of the main identifying features of Lennox Head. Its physical shape is responsible for the favorable surfing conditions that make the Point famous for surfing.

The portion of Lennox Head that hooks toward the Point as seen from the beach is shown in Figure E.3.

The lifeguard swimming zone below is in front of the Surf Life Saving Club (Figure E.4). It is one of two places people are officially encouraged to swim on the beach.

Figure E.2 Lennox Point from Green

Figure E.3 Town from Beach

Figure E.4 Life Guard Swimming Zone

Figure E.5 Healthy Dunes on Beach

Figure E.6 Unhealthy Dunes in Town

Figure E.7 Typical Dune Crossing

Figure E.8 Erosion in Town

Figure E.9 Dune Forming Fences

Figure E.10 Lack of Tertiary Vegetation

Figure E.11 Proximity of Road to Dunes

North of the town a healthy sequence of dune communities on Seven Mile Beach can be found (Figure E.5). Closer to the town, secondary and teriary vegetation has been removed to clear views to the ocean (Figure E.6). and erosion is a significant issue (Figures E.8-9).

Typical method of access to the beach, a simple path through the dunes, cuts through the dune ecosystem and disrupts its continuity (Figure E.7).

Because Pacific Parade runs close to the beach, much of the land coastward is used for either parking or kept open as lawn for views and passive recreation (Figures E.10-11).

Figure E.12 Edge of Lake Ainsworth
Image credit: Matt Schmalzel

Figure E.13 South Shore of Lake

Figure E.14 View across Lake to Camp

Lake Ainsworth is a freshwater coastal lake, a rare environmental feature. Its shore is lined by tea trees, which have over time stained the water dark brown with tannins (Figure E.12). The tree coverage breaks primarily only for access to the beach (Figure E.13). Across the lake, the boat facility of the Sports and Recreation Facility can be seen (Figure E.14).

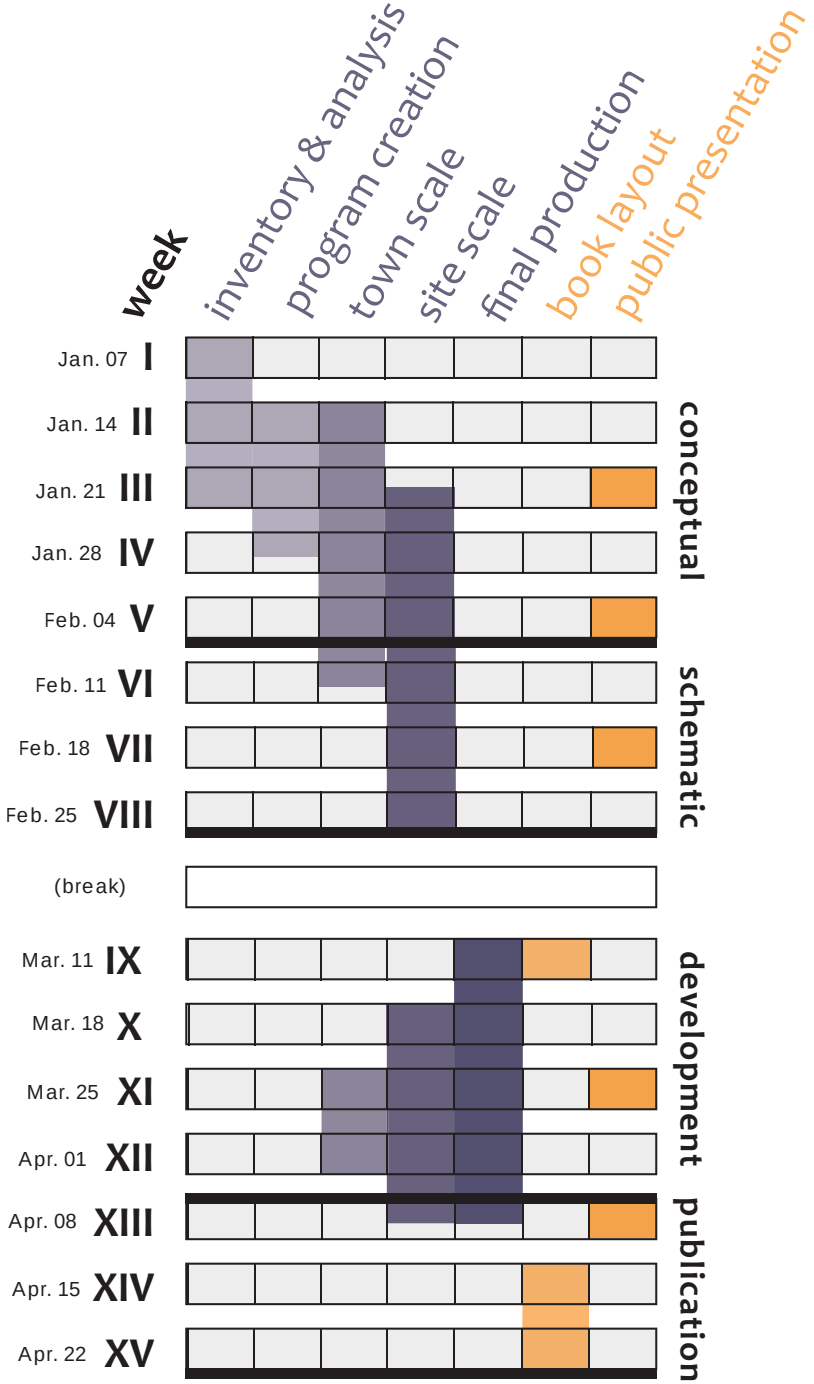
Figure E.15 Road South of Lake

Figure E.16 Caravan Park
Image credit: Google Earth

The Caravan Park attracts many visitors from out of town in an unsightly congregation (Figure E.16) which borders the south shore of the lake across from Camp Drewe Rd (Figure E.15).

[Appendix F: List of Figures]

[Appendix G: Timeline]



[Bibliography]

Australian Natural Resources Atlas. Australian Government. Department of Sustainability, Environment, Water, Population and Communities, 23 Dec. 2010. Web. 31 Oct. 2012.

Australian Bureau of Statistics. "Ballina Shire: Estimated Residential Population." *Profile.id.com*. Compiled by .id: The Population Experts. 18 Oct. 2012. Web. 15 Nov. 2012.

Ballina Shire Council. Ballina Shire Council, n.d. Web. 27 Sept. 2012.

Ballina Shire Council. *Ballina-Lennox Head Recycled Water Master Plan*. 2007. Web. 22 Mar. 2012.

--. "Ballina Shire Urban Species List." n.d. Web. 24 Nov. 2011.

--. "Illustration 1.1-Lennox North Council Preferred Route." May 2009. Web. 11 Nov. 2012.

--. "Illustration 1.2-Lennox Village Council Preferred Route." May 2009. Web. 11 Nov. 2012.

--. *Lake Ainsworth Management Plan*. 2002. PDF file. 22 Mar. 2012.

--. *Local Environment Plan.* 2011. PDF file. 11 Nov. 2012.

--. *State of the Environment Report*. 2010. PDF file. 12 Oct. 2012.

Briggs, Sue V. "Linking Ecological Scales and Institutional Frameworks for Landscape Rehabilitation." *Ecological Management & Restoration* 2.1 (2001): 28. *Academic Search Premier*. Web. 5 Oct. 2012.

Clements, Anne Marie, et al. "Construction of an Environmentally Sustainable Development on a Modified Coastal Sand Mined and Landfill Site—Part 2. Re-Establishing the Natural Ecosystems on the Reconstructed Beach Dunes." *Sustainability*, 2 (2010): 717-741. Web. 22 Sept. 2012.

Cribb, D. "After Hugo, a Better South Carolina." *Soil & Water Conservation News* 12.4 (1991): 4. *MasterFILE Premier.* Web. 10 Nov. 2012.

The Ecovillage at Currumbin. Landmatters Currumbin Valley Pty Ltd., 2012. Web. 17 Oct. 2012.

Erskine, Andy, Lisa King, and Mike Delaney. *Vegetation Management Plan: Seven Mile Beach, Lennox Head*. Environmental Training and Employment (Northern Rivers) Inc. Apr. 2002. Web. 5 Mar. 2012.

Felce, D. and J. Perry. "Quality of Life: Its Definition and Measurement." *Research in Developmental Disabilities* 16.1 (1995): 57-74. *US National Library of Medicine*. Web. 2 Nov. 2012.

GeoLINK. *Lake Ainsworth Management Plan*. NSW Department of Public Works and Services. Nov. 2002. Web. 22 Mar. 2012.

--. *Lennox Head and Ballina Cycleways/ Shared Paths: Environmental Assessment and Route Selection*. Ballina Shire Council. 2009. Web. 11 Nov. 2012.

"Gary Comer Youth Center." *Landscape Performance Series*. Landscape Architecture Foundation. Web. 2 Nov. 2012.

Green Star. Green Building Council of Australia, 2012. Web. 18 Oct. 2012.

Harker, Donald, et al. *The Landscape Restoration Handbook*. 2nd ed. Boca Raton: Lewis Publisher, 2000. Print.

Hewitt, Charlie. *Ballina Coastline Management Study: Stage Two-Management Options Assessment*. GeoLINK. 2008. PDF file.

Higgs, Eric S. "What Is Good Ecological Restoration?" *Conservation Biology* 11. (1997): 338-348. *Biological & Agricultural Index Plus (H.W. Wilson)*. Web. 21 Oct. 2012.

Hordern, Tracy. "Linnaeus Estate." *CompleteHome.* Universal Magazines. 31 July 2012. Web. 16 Oct. 2012.

Hough, Michael. *Cities & Natural Processes: A Basis for Sustainability*. New York: Routledge, 2004. Print.

---. "Design with City Nature: An Overview of Some Issues." *Ecological City*. Eds. Rutherford Platt, Rowan Rowntree, and Pamela Muick. Amherst: The University of Massachusetts Press, 1994. Print. 40-48.

"How Many People Live in Australia's Coastal Areas?" Year Book 2004. Australian Bureau of Statistics. 27 Feb. 2004. Web. 31 Oct. 2012.

Ingels, Bjarke. "Hedonistic Sustainability." *TedxEast*. May 2011. Web. 20 Sept. 2012.

Khalil, Syed M. "The Use of Sand Fences in Barrier Island Restoration: Experience on the Louisiana Coast." ERDC TN-SWWRP-08-4. Vicksburg, MS: U.S. Army Engineer Research and Development Center. Web. 3 Nov. 2012.

Knox, Paul K. and Heike Mayer. *Small Town Sustainability*. Berlin: Birkäuser Verlag, 2009. Print.

Kuo, Frances E. "The Role of Arboriculture in a Healthy Social Ecology." *Journal of Arboriculture* 29.3 (2003): 148. *Academic Search Premier*. Web. 13 Nov. 2012.

LEED 2009 for Neighborhood Development Rating System. Congress for a New Urbanism, Natural Resources Defense Council, and U.S. Green Building Council. Apr. 2012. PDF file.

The Linnaeus Estate: Byron Bay. BHCF Pty, Ltd., n.d. Web. 22 Sept. 2012.

Lister, Nina-Marie. "Insurgent Ecologies: (Re)Claiming Ground in Landscape and Urbanism." *Ecological Urbanism*. Eds. Mohsen Mostafavi and Gareth Doherty. Lars Müller Publishers, 2010. 536-547.

McMaster, Phil. Personal interview. 19 Apr. 2012.

Metro. *Green Streets*. Portland: Metro, 2002. Print.

New South Wales. Department of Land and Water Conservation. Coastal Unit. Co*astal Dune Management: A Manual of Coastal Dune Management and Rehabilitation Techniques*. Newcastle: DLWC, 2001. PDF file.

NSW Government. "Water Reclamation and Management Scheme (WRAMS)." Sydney, Sydney Olympic Park. Interpretive Signage. 11 March 2012.

Plato. Cratylus. In *Athenaze: Book II*. 2nd ed. Maurice Balme and Gilbert Lawall. New York: Oxford University Press, 2003.

"Seaside Pavilions." *Seaside*. The Town of Seaside. Web. 17 Apr. 2013.

Saunders, Marion. "Coastal Non-Floodplain Sand Lakes." Wetland Management Profile. Queensland Wetlands Program, 2010. Web. 27. Sept. 2012.

Rissel,Chris, et al. "Can a Motivational Intervention Overcome an Unsupportive Environment for Walking—Findings from the Step-By-Step Study." *Annals of Behavioral Medicine* 38.2 (2009): 137-146. *Academic Search Premier*. Web. 14 Nov. 2012.

Stratus Consulting. "A Triple Bottom Line Assessment of Traditional and Green Infrastructure Options for Controlling CSO Events in Philadelphia Watersheds." Office of Watersheds, City of Philadelphia Water Department. 2009. Web. 14 Nov. 2012.

The Sustainable Sites Initiative. *Guidelines and Performance Benchmarks: 2009*. American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center, and the United States Botanic Garden. 2009. Web. 13 Nov. 2012.

"Sydney Olympic Millennium Parklands." *Landscape Performance Series*. Landscape Architecture Foundation. Web. 11 Nov. 2012.

Van Iersel, Rob. *Ballina Coastline Management Study and Management Plan: Management Study Stage 1 Values Assessment*. GeoLINK. 2007. PDF file.

Watson, Donald and Michele Adams. *Design for Flooding*. Hoboken: John Wiley & Sons, Inc., 2011. Print. 151-168.

WBM Oceanics Australia. *Ballina Coastline Interim Measures and Action Plan*. Ballina Shire Council. 2003. Web. 22 Mar. 2012.

WBM Oceanics Australia. *Ballina Shire Coastline Hazard Definition Study: Final Report*. Web. 22 Mar. 2012.

Witt, C., M. Andrews, and R. Niven. *Ballina Shire Coastline Hazard Definition Study: Final Report*. WBM Oceanics Australia. 2003. PDF file.

Wolch, Jennifer, et al. "Childhood Obesity and Proximity to Urban Parks and Recreational Resources: A Longitudinal Cohort Study." *Health & Place* 17.1 (2011): 207-214. *Academic Search Premier*. Web. 14 Nov. 2012.